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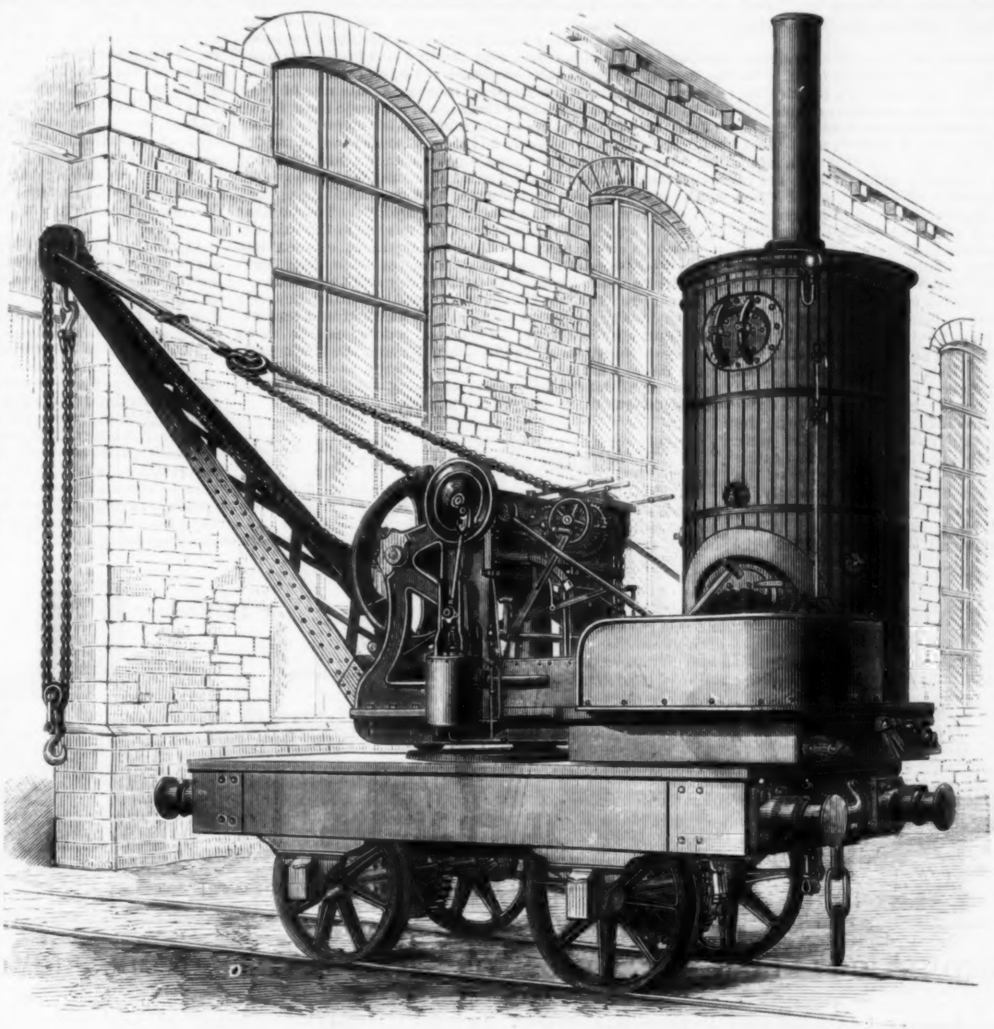
LOCOMOTIVE STEAM CRANE.

We give engravings of a locomotive steam crane designed and constructed by Mr. Thomas Smith, Steam Crane Works, Rodley, near Leeds, which is now working at the Barrow Shipbuilding Co.'s Works, and where it is employed in the erecting and fitting shops, also in the yard for shunting purposes. This pattern of crane was originally designed for Messrs. Pawson Brothers, of Morley, near Leeds, who have had one at work for a period of five months, loading material into ordinary railway trucks, and also for drawing two fully loaded trucks up an incline of 1 in 20 at the rate of four miles per hour, a distance of a quarter of a mile, the distance traveled altogether (and on which there are some sharp curves) from their works on to the main line being about a mile. The crane is fitted with two speeds for propelling (this motion being specially designed to meet the requirements of the case), quick and slow; the quick speed travels at the rate of seven miles per hour with a less weight or on the level road. To obviate the shock to the spur gearing, India-rubber springs are placed over the axle-boxes, and the wheel-base is such as to allow the crane to travel easily over ordinary curves. The gauge is the usual railway gauge.

The crane has single purchase hoisting motion fitted with a powerful friction brake and catch, so that when required the crane can be propelled with the load suspended. The revolving motion is worked with a double friction cone, so that the crane can be made to revolve in either direction without stopping or reversing the engine, and to keep the crane from slewing round when on the incline, a small brake is attached on the first motion shaft. All the gearing is of best crucible cast steel, and the central pillar is of best forged scrap iron.

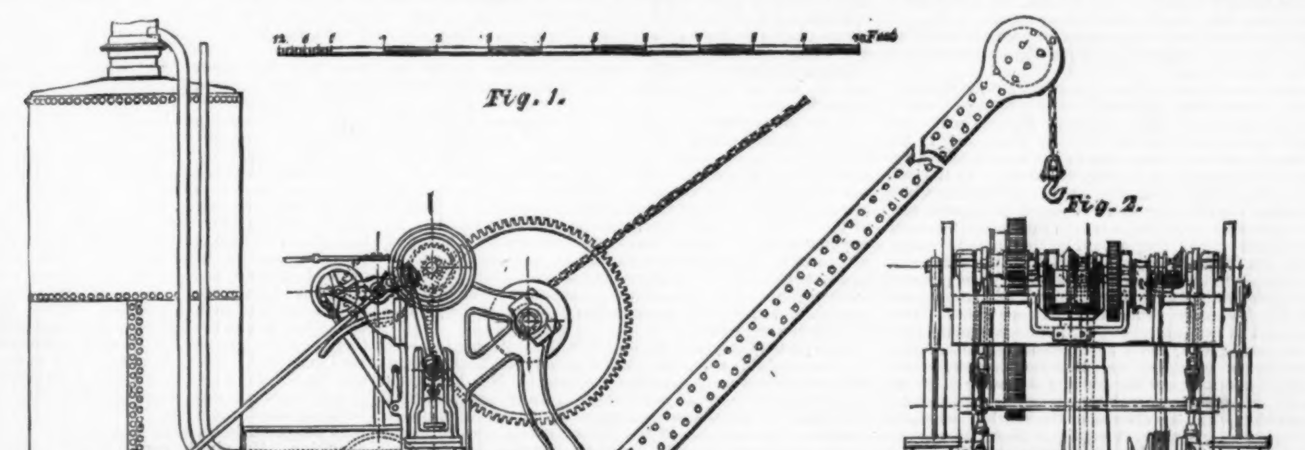
The engines consist of a pair of cylinders 8 in. in diameter by 10 in. stroke, and are each fitted with link reversing motion, and crank-shaft of steel. All the bearings are bushed with phosphor-bronze, and are adjustable. The boiler is of the ordinary vertical type, with three cross tubes through the firebox; the internal parts being of best Yorkshire iron. All the vertical seams are double riveted, and all the rivet holes are drilled in position. The boiler is fitted with the usual mountings, and also with a feed pump and a Giffard's injector. The tank is capable of holding a large supply of water, a great desideratum in a crane of this description, as it avoids the necessity of having to go for a supply between the ordinary meal hours. The crane is made to lift and propel with a load of 5 tons at a radius of 16 ft., and will lift heavier weights at a proportionately less radius, the power of the engine and strength of the gearing being such as to allow it to do this. The abovementioned weight can be lifted without fastening the crane down to the rails by means of clips. All the motions are within easy reach and control of one man, and the design generally is excellent. The total weight of the crane is 20 tons.—*Engineering.*



LOCOMOTIVE STEAM CRANE AT THE BARROW SHIPBUILDING COMPANY'S WORKS.

GRAIN ELEVATORS.

The two new grain elevators at Jersey City, opposite New York, each have a capacity of 1,500,000 bushels of grain. They contain all the most recent improvements.



LOCOMOTIVE STEAM CRANE AT THE BARROW SHIPBUILDING COMPANY'S WORKS.

CHANGING A RAILWAY GAUGE.

By AUG. MORDECAI, C.E., Cleveland, O.

THE gauge of the New York, Pennsylvania and Ohio R. R., formerly the Atlantic and Great Western R. R., was changed on June 22d last, from Leavittsburg to Dayton, a distance of 224¼ miles, from six feet to one of four feet eight and a half inches. The following account of this work may prove interesting to at least those of our narrow-gauge friends who may be contemplating a somewhat similar move:

The main line of the road extends from Salamanca on the Erie Railway, to Dayton, O., a distance of 388¾ miles. In changing the road to the standard gauge it was determined, in order to be enabled to wear out the old locomotive equipment and for other reasons, to third rail that portion from Salamanca to Leavittsburg, a distance of 164¼ miles, and narrow gauge from Leavittsburg to Dayton, a distance of 224¼ miles, with an additional 50 miles of side track and branches. It was considered best to throw in both rails, as it was thought that a large saving would thereby be effected in the cost of future maintenance over the plan of moving but one rail.

The alignment of that portion of the road which was narrow-gauged is generally straight; but portions of it, however, are quite crooked. The sharpest curve is a five degree; the longest about a mile. One five-mile section especially is a succession of three-degree reverse curves on a heavy grade. The ties will average fairly with those found on most Western roads. The iron is most of it good, joined with angle splices, but in several places it is badly battered and cut in small pieces. There are a number of bridges, all of them Howe truss, and the usual number of road-crossings and cattle-guards. This portion of the road is also crossed at grade by thirteen different railroads, obliging the change of about twenty railroad crossings, counting side tracks and all.

The engineering department of the road commenced preparing for the change two months in advance. The preparation of the track consisted of bringing it to a good line and surface and taking out some twelve miles of old chair-iron, which was done by laying the new iron to the standard guage inside of the chair-iron. Every tie was adzed, so that the rails when moved would have a solid and true bearing; this was done by fixing two boards the right distance apart beneath an ordinary gauge, and adzing the ties until the gauge had a good bearing on the rails. Inside spikes were driven in each tie, according to a template affixed to a gauge in a somewhat similar manner as above. The lining of the track and this spiking should be done very carefully, as upon it depends the line of the track after being thrown in, which will be bad if the spiking is carelessly done. A day or two before the day of change all the inside spikes were drawn except from five to nine in each rail, depending upon the quality of the ties whether on a curve or straight line, etc. Pieces of rails were also cut and inserted on the curves to allow for the difference in their length, but it was afterward found that this was an unnecessary labor.

The preparation of the bridges and cattle-guards consisted of laying extra track-stringers the right distance apart, and driving the inside spike.

The preparation of the railroad crossings consisted, in the case of steel plated frogs, of merely cutting pieces of rail of such lengths that when the frogs were moved in the old rails could be taken out and replaced by those cut to the proper length, and we believe that in but one instance was it necessary to cut a rail on the day of change. In the case of rail-crossings, wherever the above arrangement was impracticable, the old frogs were replaced with new ones that had a piece let in of such a length that, when taken out and the frogs moved in, they would be to the right gauge. Rails were cut for the leads on side-tracks in a similar way. The switch-rods in the case of split switches were prepared by welding the solid clamps to two pieces of gas-pipe, one of which fitted into the other like telescope tubes. They were punched in two places, one for the board and the other for the standard gauge, and a key fastened them securely. The operation of changing was, therefore, simple, merely consisting of knocking out the key and replacing it in another hole. In the case of stub-toe switches, each rod was either provided with four clamps, or the Gurley switch-rod was used; in the latter, by changing a piece of gas-pipe from the inside to the outside of the rail, the change was easily made.

That the switch and connecting-rods are of the proper length should be most carefully determined, as it was found that the operation of narrowing "moving bars" was the most annoying on the day of change, in some places necessitating the moving of the head-block, in order to make the connecting-rod fit.

After these preliminary steps were arranged and properly carried out, the work for the actual day of change was commenced by distributing tools two days before. Those men who could be spared from other portions of the road, or were borrowed from other roads—and the managements of neighboring roads were extremely kind in furnishing men—were divided into gangs of a foreman and ten men, and distributed by regular passenger trains on the afternoon of the 21st. The gangs were all numbered, and as it was arranged by printed circulars where each was to work, there was no delay or confusion in distributing them. The arrangements for bed and board had all been made previously by a man especially appointed for the purpose. The foreign men were not required to bring their tools. It would have been better, perhaps, to have allowed them to bring their spike mauls, as those furnished were not satisfactory in all cases.

The N. Y., P. and O. R. R. is divided into roadmaster subdivisions of fifty miles long, and these again subdivided into sections of five miles. The general arrangement on the day of change was to have two gangs, consisting of a foreman and ten men each, at each end of a section, one on each rail working toward each other. At each end of a subdivision there was a narrow-gauge train in charge of a roadmaster running toward the center. The train consisted of an engine and two or three cars carrying spare tools, water, and lunches for those men requiring them. These lunches were done up separately in paper bags and placed in baskets, five in a basket, an arrangement which seemed to work admirably.

Everything being thus prepared, and the last broad-gauge train being, by the efficiency of the transportation department, off the road at 3:35 A.M., promptly at 4 o'clock on June 22, the men were at work, and by 9:30 the same morning the entire main line and sufficient side track to do the necessary business was narrow-gauged, and by 2 in the afternoon, news having been received by the chief engineer that all the trains had met and the line had been thoroughly tested, the road was declared open, and half an hour afterward trains were rushing over it at the rate of fifty miles an hour, and making their usual schedule time, being a delay of but ten hours in the business of the road. Some sections were done as early as half-past six in the morning, but the average time for changing two and a half miles of main track was about three and a half hours, with two gangs, consisting each of one foreman, two men pulling spikes, two men throwing in the rail, and six spikers. The number of outside spikes driven was from six to nine to the rail, depending on circumstances. The arrangement of men was particularly conducive to fast working, as each gang, having a like amount to do, was anxious to excel the others.

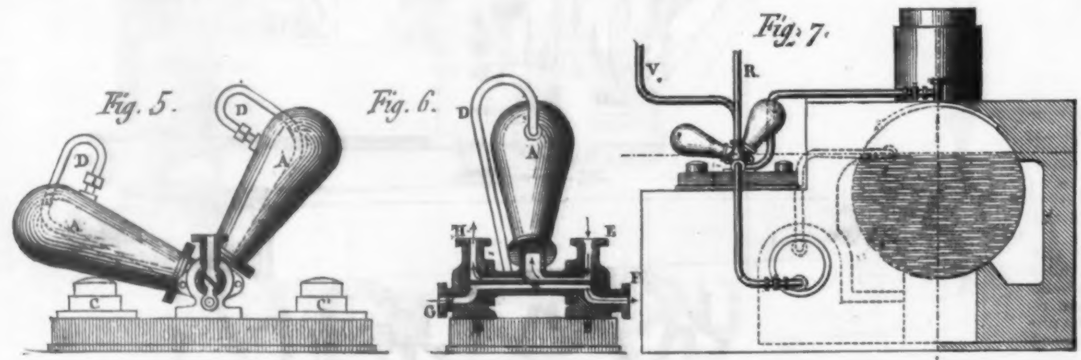
The entire work was thus accomplished most satisfactorily and successfully without a single accident and in a remarkably short space of time. There was a delay caused by an engine attached to a freight train leaving the track while going on to a siding, but this was, perhaps, as much due to the gauge of the engine wheels as to any fault in the work of narrow-gauging.—*Engineering News.*

AUTOMATIC FEEDING APPARATUS FOR STEAM BOILERS OF MR. FROMENTIN.

THE feeding apparatus of Mr. Fromentin (Figs. 5, 6, and 7) consists of two receivers, of the same weight and same capacity, which are placed symmetrically on each side of a hollow axis, which turns on two pivots, and around which they oscillate alternately. Two pads, C, serve to lighten the shock of these receivers. The two tubes, D, bring the upper part of each of the receivers successively in communication with the hollow parts of the axis, which are connected by the tubulures, E and F, through which the water, coming from a higher placed reservoir, enters into the boiler. Each pivot of the axis consists of an entrance tap and an outlet tap, which are influenced by the movement peculiar to the apparatus, and permit the passage of the water and the steam through pipes.

Fromentin's apparatus has nothing in common with the ordinary pumps and injectors, and the only resistance which it has to overcome by the introduction of the water is that which is produced by the tubes, consequently it is not subject to the perturbances which so often occur in the pumps of other apparatus; and more, it permits the feeding of the boiler with hot water, and the heat that was lost by the condensation of the steam is thus restored. The apparatus can be employed with all boilers, and can be put up at any place, even if the place is on a level with the water in the boiler. Fig. 7 represents an apparatus which is thus placed, and in which V is the steam pipe and R the pipe for the feeding of water.

Several boilers which are united with a battery can be fed by means of this apparatus; but to avoid practical difficulties and apparatus of too great dimensions, Mr. Fromentin has proposed the use of two receivers, which are connected with those of the feeding apparatus by means of a single conduit. At each side of the pivots which constitute the entrance tap and the outlet tap of the steam and the feeding water, there is a tube, which is connected alternately, and according to the same principle, with the intercalated apparatus, *i. e.*, the pivots permit a multiple distribution.



AUTOMATIC FEEDING APPARATUS FOR STEAM BOILERS OF MR. FROMENTIN.

A REMARKABLE GAS-EXPLOSION.

THOSE who frequent our busy town thoroughfares have little idea of the perils to which they are exposed, and we venture to say, not one in ten thousand of the inhabitants of London could have predicted such a calamity as that which happened on Monday, July 5. Apart from the fearful havoc and destruction to life and property it has caused, the disaster, the details of which are published, raises an important question which must speedily be answered, namely, upon whose shoulders the responsibility of superintending gas and sewer works should fall. To ascertain the extent of the damage the explosion along the line of the new gas main has caused, we have inspected the route. It appears that the Gas Light and Coke Company had been laying down a new main, 36 in. diameter, from the main in Goswell Road, which passed along Guilford Street, through Russell Square, Montague Place, Bedford Square, after which it crossed Tottenham Court Road, and was being carried through Percy Street and Charlotte Street to join the trunk main at Howland Street. Some portion of this main, to a point in Baily Street, where the first explosion occurred, had been in use, and the remaining portion, along the route of which so much damage has been done, had only recently been laid, and had either just been or was about to be connected with the existing mains. It was while testing this portion of the pipe, we understand, before leaving the work for the night, that the accident happened. Percy Street and Charlotte Street show the greatest extent of havoc due to the explosions. Half-way down the former street we come upon a large opening where the gas has blown through two vaults, and torn up the roadway over the main pipe, which remains as left by the explosion. The houses on this side of the street are fearfully battered, but no considerable structural damage appears to have been done, as alleged by some of our contemporaries. All the windows on both sides of the street at this point have been blown in, more or less, and the houses present the appearance of having been bombarded by artillery. To show the force of the explosion we may observe that we saw a large piece of a stone cornice to one of the houses had been broken off by one of the granite stones of the road, which had been violently propelled against it. In other cases large stones and fragments of brickwork have been hurled with considerable violence, the copings and other stonework are chipped, and the brickwork of the walls damaged in places. Some of the stones and *débris* were shot over the houses, in some cases passing over them, damaging the rear premises, and in other instances smashing through the roof and doing other mischief. Garret and other window frames are here and there displaced or broken.

At the junction of Percy Street with Charlotte Street, which returns northwards at right angles, another explosion took place. Here the vaults of a shop have been blown in, and the brick pier below the shop window has been thrown down, and it was probably due to the sudden turn in the direction of the explosive wave, that so considerable a havoc has been made at this point.

Another gaping chasm occurs further north, which has rendered the road impassable, and several houses have severely suffered from the effects of the explosion. Two other eruptions, one at the crossing of Howland Street, are to be seen, though of less magnitude.

Luckily, the pier blown down at the end of Charlotte Street did not affect the work over, as the shop window intervened between it and the breastsummer, but with this exception (and, altogether, we find six upheavals of the roadway have taken place) we find no house front, or wall, seriously or structurally damaged, and none blown down. But, allowing for exaggerated statements, the injury done is serious and alarming enough, and calls for immediate and searching inquiry. We are told by one account that the total length of the new main was two miles, that six hundred yards of it from Tottenham Court Road, through Percy and Charlotte Streets, had been completed, and only required the connection with the old trunk to be made. Between the two sections from Tottenham Court Road, one running eastwards and the other westwards, a short distance intervened of about twenty-four feet.

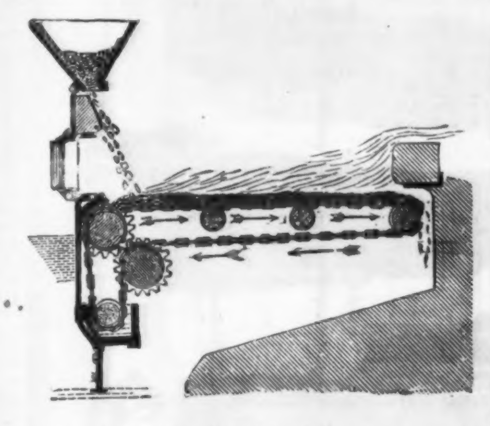
Air had been pumped into the new pipes by the contractors for the purpose of testing, and it only remained to fill in the twenty-four foot gap with pipes, and to turn on the gas from the main in Howland Street, and to watch the air hole at the other end at Goswell Street, to see when the air had been driven out, and to close up the aperture. It was by some inadvertence at this juncture that the explosion took place. There must in the first place have been a mixture of air and gas in the main of the explosive proportion, or one in fifteen; and, secondly, by some carelessness, this must have been ignited. It is said the pressure gauge gave no indication of such a mixture, nor was any smell of gas perceived; but in the face of such an unparalleled explosion there is some ground for thinking sufficient care had not been exercised. There is always risk in forcing gas into a new pipe where a certain amount of air may be, and a satisfactory answer is now required before the same method can be safely employed again. It is certain the main must have been dangerously charged with gas and air in an explosive condition. Here in the course of half a mile a series of violent explosions, tearing up the roadway and causing a panic of dismay of an unprecedented kind, has happened from some unscientific mode of connection, or some accident. If the former cause, gas engineers have something yet to learn; if the latter, precautions should be taken to render even a mistake harmless.

It is as well to remember that two conditions are necessary for an explosion of gas: first, the mixture of a certain proportion of gas with the air, and the next, that it be in a confined position. The pipes could not have been full of gas, but of this explosive compound, and when the light was applied, the explosion ran along the main and burst out with increased force at weak points. There ought to be some means of testing the condition of a main, or of forcing the air out more effectively. These are points we hope the pending inquiry will settle; but it still leaves the question we put at the beginning. With the divided jurisdictions under which the metropolis groans, there appears to be no control exercised over the operations of companies, who seem to have the power to open our roadways and to perform work fraught with danger to a whole neighborhood. At present we suffer a constant breaking up and patching up

of the roads. No sooner is a main sewer laid or repaired than the water companies commence a similar operation, and this is repeated by the gas company with an additional amount of risk we have only just experienced. What with sewers, water and gas mains, and tramway lines, the long-suffering public and ratepayer are never exempt from the inconvenience and obstruction created by them; but when to these is added the risk of underground explosions, it seems to us the time has come either for a metropolitan municipality, as proposed, or some other reasonable guarantee of security to life and property.—*London Building News.*

CHAIN FIRE-BARS.

A BOILER in the Birmingham Corporation Waterworks has been fitted several months with the arrangement of common chain fire grate invented by Mr. W. Welch, of Aston Village, near Birmingham, as illustrated in the annexed woodcut. This furnace is 6 ft. by 3 ft. 6 in., and has been at work day and night since the 29th of April with satisfactory results. We are informed that the fuel is wholly burned without smoke, that the fire is no trouble, and the grate as



perfect as when put in. It is claimed for the arrangement that the large and completely distributed air space area permits the maintenance of a clear smokeless fire without a keen draught, perfect combustion being secured. Clinkers do not adhere to the chains, and the latter may be worked either with or without the water trough. The arrangement of the grate will be readily understood from our sketch, which shows it to be simple.—*The Engineer.*

SIR HENRY BESSEMER.

HENRY BESSEMER, whose name will be for ever associated with the manufacture of steel, may be truly said to have been born an inventor. The youngest son of Mr. Anthony Bessemer—a country gentleman who was himself an inventor—he was born at Charlton, in Hertfordshire, in 1813. His boyhood was spent in his native village, and while there receiving the rudiments of a good education, the leisure and retirement of rural life afforded ample time, though perhaps very little inducement, for the display of the natural bent of his mind. Notwithstanding his scanty and imperfect mechanical appliances, his early years were devoted to the cultivation of his inventive faculties. Some of his first efforts were directed to the creation of designs and models in clay, and even in this primitive school of genius he worked with so much precocity and success that at the age of nineteen he exhibited one of his beautiful models at the Royal Academy, then held at Somerset House. His father soon perceived the superior powers of Henry's mind while he was yet a lad; and on the occasion of one of his visits to London purchased for the young hopeful "one of those beautiful little five-inch foot-lathes made by Holtzapffel," and with this instrument Henry began to study the art of turning. Aided by a book, published by the same firm, that showed by many excellent illustrations the process of eccentric turning, he devoted himself to the study of the art with all the enthusiasm of genius and youth.

At that time Jacob Perkins caused some sensation by his achievements in eccentric turning applied to the engraving of bank notes; and young Bessemer so much admired this man's work that he took the only little bit of turning he had to do to Perkins, in order that, notwithstanding its unusually high price, he might have the privilege, as he esteemed it, of examining workmanship which he considered so beautiful and difficult. "I examined," says Henry, "a vast number of beautiful specimens, and could not conceive how by any combination of mechanical appliances they could be produced until I came across a pattern where there was a false division. Some accident to the machine had produced the deflection of a single line among many thousands, and I was thus enabled in a moment to learn the whole secret. In three months from that time I produced all those patterns by the simplest possible means."

Circumstances rendering young Bessemer dependent on his own exertions, he left his native village at the age of 18 years and took up his residence in London. His father wisely determined to let his son's mind have free scope, and afforded him every facility in his power to cultivate and expand his faculties. With this view Henry was not restricted to any profession whose round of duties might absorb his mind or exhaust his energy. Coming to London from his native village while yet "a lad in his teens," he knew nobody and nobody knew him; but in the prosecution of his inventive studies he soon began to make his way, and in the course of two years he was maturing some plans in connection with the production of stamps which he thought would lead him on to fortune.

At that time the old form of stamps was in use that had been employed since the days of Queen Anne; and as they were easily transferred from old deeds to new ones, the government lost a large amount annually by this surreptitious use of old stamps instead of new ones. The ordinary impressed or embossed stamps, such as are now employed on bills of exchange, or impressed directly on skins of parchment, were liable to be entirely obliterated if exposed for some months to a damp atmosphere. A deed so exposed would at last appear as if unstamped, and would therefore become invalid. Special precautions were, therefore, observed in order to prevent this occurrence.

It was the practice to gum small pieces of blue paper on the parchment, and, to render it still more secure, a strip of metal foil was passed through it, and another small piece of paper, with the printed initials of the sovereign, was gummed over the loose end of the foil at the back. The stamp was then impressed on the blue paper, which, unlike parchment, is incapable of losing the impression by exposure to a damp atmosphere. Experience showed, however, that by placing a little piece of moistened blotting-paper for a few hours over the paper the gum became so softened that the two pieces of paper and the slip of foil could be easily removed from an old deed, and then used for a new one. In this way stamps could be used a second and third time; and by thus utilizing the expensive stamps on old deeds of partnerships that were dissolved, or leases that had expired, the public revenue lost thousands of pounds every year.

Sir Charles Persley, of the Stamp Office, told young Bessemer that the government were probably defrauded of £100,000 per annum in that way. The young inventor at once set to work for the express purpose of devising a stamp that could not be used twice. His first discovery was a mode by which he could have reproduced easily and cheaply thousands of stamps of any pattern. "The facility," he says, "with which I could make a permanent die from a thin paper original, capable of producing a thousand copies, would have opened a wide door for successful frauds if my process had been known to unscrupulous persons, for there is not a government stamp or a paper seal of a corporate body that every common office clerk could not forge in a few minutes at the office of his employer or at his own home. The production of such a die from a common paper stamp is a work of only ten minutes; the materials cost less than one penny; no sort of technical skill is necessary, and a common copying press or a letter stamp yields most successful copies."

To this day a successful forger has to employ a skillful die-sinker to make a good imitation in steel of the document he wishes to forge; but if such a method as that discovered and described by young Bessemer were known, what a prospect it would open up! Appalled at the effect which the communication of such a process would have had upon the business of the Stamp Office, he carefully kept the knowledge of it to himself, and to this day it remains a profound secret.

More than ever impressed with the necessity for an improved form of stamp, and conscious of his own capability to produce it, he labored for some months to accomplish his object, feeling sure that, if successful, he would be amply rewarded by the government. To insure the secrecy of his experiments, he worked at them during the night after his ordinary business of the day was over. He succeeded at last in making a stamp which obviated the great objection to the then existing form, inasmuch as it would be impossible to transfer it from one deed to another, to obliterate it by moisture, or to take an impression from it capable of producing a duplicate.

Flushed with success and confident of the reward of his labors, he waited upon Sir Charles Persley at Somerset House, and showed him by numerous proofs how easily all the then existing stamps could be forged, and his new invention to prevent forgery. Sir Charles, who was much astonished at the one invention and pleased with the other, asked young Bessemer to call again in a few days. At the second interview Sir Charles asked him to work out the principle of the new stamping invention more fully. Accordingly Bessemer devoted five or six weeks' more labor in perfecting his stamp, with which the Stamp Office authorities were now well pleased.

The design, as described by the inventor, was circular, about 2½ in. in diameter, and consisted of a garter with a motto in capital letters, surmounted by a crown. Within the garter was a shield with the words "Five pounds." The space between the shield and the garter was filled with network in imitation of lace. The die was executed in steel, which pierced the parchment with more than 400 holes, and these holes formed the stamp. It is by a similar process that valentine makers have since then learned to make the perforated paper used in their trade. Such a stamp removed all the objections to the old one. So pleased was Sir Charles with it that he recommended it to Lord Althorp, and it was soon adopted by the Stamp Office.

At the same time Henry Bessemer was asked whether he would be satisfied with the position of Superintendent of Stamps with £500 or £600 per annum as compensation for his invention instead of a sum of money from the Treasury. This appointment he gladly agreed to accept, for being engaged to be married at the time, he thought his future position in life was settled. Shortly afterwards he called upon the young lady to whom he was engaged and communicated the glad tidings to her, and showed her the design of his new stamp. On explaining to her that its chief virtue was that the new stamps thus produced could not, like the old ones, be fraudulently used twice or thrice, she instantly suggested that if all stamps had a date put upon them they could not be used at a future time without detection. This idea was new to him, and, impressed with its practical character, he at once conceived a plan for the insertion of movable dates in the die of his stamp.

The method by which this is now done is too well known to require description here; but in 1833 it was a new invention. Having worked out the details of a stamp with movable dates, he saw that it was more simple and more easily worked than his elaborate die for perforating stamps; but he also saw that, if he disclosed his latest invention, it might interfere with his settled prospects in connection with the carrying out of his first one. It was not without regret, too, that he saw the results of many months of toil and the experiments of many lonely nights at once superseded; but his conviction of the superiority of his latest design was so strong, and his own sense of honor and his confidence in that of the government so unsuspecting, that he boldly went and placed the whole matter before Sir Charles Persley. Of course the new design was preferred. Sir Charles truly observed that with this new plan all the old dies, old presses, and old workmen could be employed. Among the other advantages it presented to the government, it did not fail to strike Sir Charles that no superintendent of stamps would now be necessary—a recommendation which the perforating die did not possess. The Stamp Office, therefore, abandoned the first invention of Bessemer in favor of his latest one, which is still in use. At the same time the government abandoned the ingenuous and ingenious inventor. The old stamps were called in and the new ones issued in a few weeks; the revenue from stamps grew enormously, and forged or feloniously used stamps are now almost unheard of. The Stamp Office reaped a benefit which it is scarcely possible to estimate fully, while Bessemer did not receive a farthing. Shortly after the new stamp was adopted by Act of Parliament Lord Althorp resigned, and his successors disclaimed liability. When the disappointed inventor pressed his claim, he was met by all sorts of half promises and excuses, which ended in nothing. The disappointment was all the more galling, because if Bessemer had stuck to his first adopted plan his services would have been indispensable to its execution; and it was therefore through his putting a better and more easily worked plan before them that his services were coolly ignored. "I had no patent to fall back upon," he says, in describing the incident now; "I could not go to law, even if I wished to do so, for I was reminded when pressing for mere money out of pocket that I had done all the work voluntarily and of my own accord. Wearied and disgusted, I at last ceased to waste time in calling at the Stamp Office—for time was precious to me in those days—and I felt that nothing but increased exertions could make up for the loss of some nine months of toil and expenditure. Thus, sad and dispirited, and with a burning sense of injustice overpowering all other feelings, I went my way from the Stamp Office too proud to ask as a favor that which was indubitably my right."

His next invention was of a more ingenious and profitable character. When engaged in ornamenting a vignette in his sister's album with some gold bronze, he was struck with the great difference between the raw material and the manufactured bronze—the one sold for a shilling and the other for a hundred shillings a pound. Finding on inquiry that this was owing to the prolonged and laborious process employed in converting the raw material into bronze, he thought he could construct a more simple mechanical means that would diminish the cost of production. Other men had labored in vain to do this; but it is the highest attribute of genius to succeed where others fail, and impelled by this instinct he labored incessantly for nearly two years in the construction of machines for making bronze powder, and at last success crowned his efforts. He made five different self-acting machines, which superseded hand labor altogether in the process of manufacture, and by which, with the aid of two attendants, as much bronze powder could be produced daily as sixty skilled operatives were capable of producing on the old hand system.

Warned by the bitter experience of his first invention, Bessemer took care not to make known the secret of this one, and to this day the mechanical means by which his famous gold paint is produced remains a profound secret. The machinery is driven by a steam engine in an adjoining room; and into the room where the automatic manufactory is at work none but the inventor and his assistants have ever entered. When a sufficient quantity of work is done a bell is rung to give notice to the engine man to stop it, and in this way the machinery has been in constant use for forty years without having been either patented or pirated. Its profit was as great as its success, and by means of it he was able to devote himself more exclusively to experiment and research with the view of making new inventions in other departments of art and industry. At first he made one thousand per cent. profit; and though there are other products that now compete with his bronze, he still reaps three hundred per cent. profit, and is the exclusive manufacturer of it.

In the course of the next few years he directed his attention to the manufacture of ordnance, which was then in its primeval state. Seeing ample room for improvement, he made numerous experiments with a view to improve the efficiency of the existing cannon, and succeeded at the time of the Crimean war in inventing a system of firing elongated projectiles from smooth-bore guns. He submitted this invention to the English Government, but it was rejected without even a trial. Shortly after his own Government had scorned to try his new system, he happened to be at a dinner given in Paris to General Hamlin and other French officers before their departure for the Crimea. Prince Napoleon was among the guests, and after dinner he entered into a conversation with Bessemer on artillery. The inventor, of course, took occasion to mention his new invention for firing elongated shot from smooth-bore guns. The Prince was much interested in the subject, and arranged an interview between the inventor and the Emperor for the purpose of explaining it. The result was that Bessemer was asked by the Emperor to continue his experiments for the benefit of the French Government. The Emperor sent him blank checks in payment of his labors, and Bessemer in turn made a great many projectiles which on trial gave very satisfactory results. After testing some of these projectiles with a light cast-iron gun, Commander Minnie remarked that they were all right, but unless the guns were made of better metal such strong projectiles would be of little use. This remark opened up a new field of experiment to Bessemer. The idea of making a better quality of metal now flashed across his mind for the first time, and he instantly determined—

"To brave the perils that environ
All men who dabble in cast iron."

A few days afterwards he communicated to the Emperor his intention of studying the whole subject of metals specially suitable for artillery, and, encouraged by the Emperor's continued patronage, he began at once to study metallurgy. He not only read the best works on the subject, but he made himself practically acquainted with the working of the different processes of making iron then in use. After about twelve months of experiments he succeeded in producing malleable iron of remarkable purity, and cast it into small cannon of a miniature size. One of these guns he presented to the Emperor; another he retains to this day as a *souvenir* of his early labors.

Still he had not yet struck the key-note of his great invention. Not till many more experiments had been tried and many failures been experienced did it occur to him that the mechanical application of oxygen at high pressure to the fluid metal might produce an intense state of combustion in which the deleterious elements would be consumed or expelled. This was the upshot of nearly two years' experiment, conducted at a cost of three or four thousand pounds. No sooner, however, had his mind conceived the idea of applying the simple law of nature which produces flame and combustion than he began to design apparatus for this purpose.

He constructed a converter, and ordered a small powerful blast engine and a quantity of pig metal to be put down on premises that he had hired for carrying on his experiments. The name of these premises was Baxter House, St. Pancras, and the simple experiment we are now going to describe has made that name for ever famous. The iron which was supplied to him happened to be good Blaenavon. The engine was made to force streams of air under high pressure through a vessel lined with fireclay, and the stoker was told to pour the metal "in there" when it was sufficiently melted. A cast-iron plate—one of those lids which commonly cover the coal-holes in the pavement—was hung over the receiving vessel; and all being now ready, the stoker, in undisguised bewilderment, poured in the metal. Out came a volcanic eruption of such dazzling coruscations as had

CARLISLE CATHEDRAL. DRAWN BY S. READ.

never been seen before. The dangling pot-lid dissolved in the gleaming, seething mist, and the chain by which it hung grew red and then white as the various stages of the process were unfolded to the gaze of the wondering spectators. The air-cock to regulate the blast was beside the converting vessel, and no one dared to go near it, much less to deliberately shut it. In this dilemma, however, they were soon relieved by finding that the process of decarburization had expended all its fury; and, most wonderful of all, the result was steel! The new metal was tried. Its quality was good. The problem was solved. The new process was successful. Bessemer was elated.

"It is natural," says Emerson, "to believe in great men." But experience has shown that it is not natural to believe in great inventions. This was Bessemer's experience in the early days of his new process for making steel. When the news of his first success began to spread among those interested in the trade, many distinguished men went to Baxter House to see the converter in operation. The Duke of Wellington went, not once, but often. By invitation, too, Mr. George Rennie inspected the working of the new process, and on seeing it exclaimed, "Do you know, Mr. Bessemer, what you are about? This must not be hid under a bushel. The British Association meets next week at Cheltenham; if you have patented your invention draw up an account of it in a paper, and I'll have it read in Section G." Acting on this suggestion Mr. Bessemer wrote out a description of his new invention, entitling it "The Manufacture of Iron and Steel Without Fuel." He then went down to Cheltenham, and was breakfasting next morning in the coffee room of the Queen's Hotel with Mr. Clay, of the Mersey Steel Works, when a gentleman who did not know Mr. Bessemer said, "Clay, I want you to go with me this morning. There is a fellow who has come down from London to read a paper on making steel from cast-iron without fuel! Ha! ha! ha!" Mr. Clay consented to go, and in an hour or so the three were in the meeting room. The paper of Mr. Bessemer was first on the list, and as soon as it was read Mr. James Nasmyth rose and expressed his approval of the principles of the invention. Next rose the gentleman who had ridiculed the discovery in the inventor's presence at the breakfast table, and stated that he was already so impressed with the prospects of the invention that he would place the whole resources of his large ironmaking establishment at Mr. Bessemer's disposal at once, in order to work the process on a large scale. For the present all seemed to promise well. Baxter House was crowded almost daily to see the converter at work, and the Ebbw Vale directors made him an offer of £50,000 for the patent, half in cash and half in shares of the company. Again flushed with success, the inventor declined this handsome offer.

But these fair prospects were destined soon to be overcast. "It is difficult," observed Mr. Isaac Lowthian Bell, nearly twenty years afterwards, "to say whether science or art was more perplexed at the announcement of Mr. Bessemer's process. The former appears to have thought it prudent to remain silent—at all events in the transactions of the British Association—for all the notice there bestowed on Mr. Bessemer's discovery is the bare mention of the title of his communication. Art was less reticent, for I remember the ridicule with which the proposal was received." At first received with a shout of triumph, the new process was next declared to be impracticable; and so general was this opinion that the inventor himself filled two portfolios with cuttings from scientific and industrial papers intended to demonstrate that his invention was the production of a visionary. Worst of all, the process itself seemed to fail; and the cause of that failure took nearly two years to find out. It was only after repeated and costly experiments that the refractory nature of phosphorus in the metal was fully ascertained. By pure chance Blaenavon iron was used in the first experiments, and when other and inferior qualities were thrown at random into the converter they did not work. At last it was found that the presence of a thousandth part of phosphorus in the iron was fatal to the success of the process, and rendered the metal incapable of conversion into steel. Having proved this to be the case, Bessemer got analyses of all the iron ores in the United Kingdom, and finding that the purest and lowest in phosphorus was the hematite of Cumberland, he ordered some pig-iron from Workington and tried it in the converter. Again he was disappointed, for it was as bad as the inferior qualities which he had previously discarded. Analysis showed, to his surprise, that the reason for this failure was the presence of more phosphorus in the iron than there was in the ore. This led him to suspect that there was something wrong in the manufacture of the crude iron. He, therefore, wrote to the manager and directors of the iron works at Workington, asking permission to examine their whole system of iron making, and holding out a prospect of thereby being able to find out something that might benefit both him and them. The directors invited him to dinner, and after discussing the object of their meeting, the manager showed Bessemer all over the works and explained every detail of their working. But the keen eye of Bessemer could detect nothing wrong—nothing that would account for the presence of more phosphorus in the iron than was in the ore. He, therefore, gave up the search as hopeless, and in company with the manager was crossing the yard from the works on his way back to the dining-room where the directors were still sitting, when he observed a heap of matter in a corner, and asked the manager what it was.

"Oh, it's nothing worth noticing," was the reply; "it's only mill cinder that we get from Staffordshire and use as a flux."

Bessemer insisted on looking at it, and on examination exclaimed:

"Oh, here it is; this is what gives the additional phosphorus to the iron."

Satisfied that he was right, he entered the directors' room, and with an air of triumph said:

"We've caught the villain; the secret's out now; it's that mill cinder that does the mischief to your iron."

He then advised them to abandon that material as a flux, and asked them to make for him one hundred tons of iron without using that flux. The order was duly executed, and when the iron so made was put into the converter, Bessemer was delighted to find that it worked admirably. These pigs were marked B, and were the first of that quality which is now universally known as Bessemer pig.

Having converted it into steel, he instructed his friend Mr. Galloway, of Manchester, to distribute the new metal among his workmen when they asked for steel to make tools with, but not to let them know that it was in any way different from what they had been accustomed to use. This was done. The steel was distributed in the usual way to make tools with, and in six weeks Bessemer returned to Manchester to hear what was the result.

"What do the workmen say about the new steel?" inquired the anxious inventor, concerning the first product of his infant industry.

"They have said nothing at all about it," replied Mr. Galloway.

"Nothing at all! Oh, then it will be all right; if they have no fault to find with it, that is the best report of any."

Not content, however, with this silent commendation, Bessemer went round among a few of the workmen, and in course of conversation asked what they thought of the steel they had got last. The first reply to his question was:

"There's no difference between it and other steel; it's no better than we used to get."

Such a recommendation was sufficient. The steel they formerly used cost from £40 to £50 a ton; this new steel cost from £8 to £10 a ton.

The difficulty at first caused by the presence of phosphorus threw so much discredit on the Bessemer process that manufacturers were now indisposed to use it; but while they were incredulous or inappreciative, Bessemer himself was so satisfied that he had at last gained a knowledge of all the conditions necessary to insure success that he started works of his own at Sheffield, and worked the process there. His steel gradually gained in public favor, and other manufacturers afterward perceived that his new metal was seriously interfering with the sale of theirs.

Thus one after another they made terms with the now successful inventor for the use of his process, until not only in England but on the Continents of Europe and America it was in general use. Sweden, whose rich ores were the most suitable for it, was the first foreign country to adopt it. The Crown Prince of that country personally inspected the first operations of the Bessemer process there. The King of Wurtemberg, the Emperor of Austria, and the Emperor of France not only expressed their thanks to the inventor for the benefit of his converter, but they decorated him with their highest marks of honor. The United States have no decorations or titles to bestow, but they were not behind their older competitors in doing honor to his name. A town was then opening up in a part of Cincinnati where coal and iron are abundant, and they gave it the name of Bessemer. The country that was the last to bestow a national recognition upon Bessemer's services to metallurgy was England. It was not till the middle of last year that the honor of knighthood was conferred on him. His invention, too, was patented in all these countries, with the exception of Germany, where a patent was refused on the pretext that the invention was an old one!

According to his own computation he has received no less than 1,057,748 "of the beautiful little gold medals which are issued by the Royal Mint, with the benign features of Her Most Gracious Majesty Queen Victoria stamped upon them." It took five years—1854–9—to perfect his process, but at the latter date it may be said to have come perfect from its creator's hands. Sixteen years afterward there were nearly 100 Bessemer steel works, containing 3,300 converters, employed in the production of steel, and the total production was over 2,000,000 tons a year. One-third of that machinery and production belonged to England. If that quantity of steel had still to be made by the old processes, it would cost at least £40,000,000 more than its present price.

In connection with the improvement of his converter, Bessemer took out twenty-six patents, but in the course of his lifetime he has taken out one hundred patents for inventions, and has paid the Stamp Office about £10,000. His miscellaneous inventions relate to the construction of railway brakes, the manufacture of glass by a new construction of furnaces, the preparation of new pigments, improvements of machinery for refining sugar, the construction of projectiles, ordnance, etc. The specifications of these inventions, which embrace a very extensive range of subjects, form two large volumes, and can scarcely therefore be enumerated here. His steel converter is certainly his greatest achievement, and has been the most extensively used of all his inventions.

Ten years after the success of his converter was demonstrated he invented another kind of furnace, based to some extent on the application of the known properties of oxygen which led to his conception of the converter. About 1868 he labored hard to make a furnace capable of yielding a greater heat than had ever been attained in that way before. It was like a steam boiler in shape, and the chief feature of its working was the use of compressed air. He contrived to force the air into it at a pressure of 20 lb. to the square inch, and by only allowing a small hole of 1½ in. diameter for its escape, the internal pressure was kept at 15 lb. or 16 lb. above the external air, or equal to two atmospheres. With this double supply of oxygen the increase of temperature was enormous. A piece of iron weighing 13½ lb., put in cold, was melted to the fluidity of water in five minutes; and 3 cwt. of malleable iron was fused in fifteen minutes. Ordinary furnaces would have taken nearly as many hours. His labors and experiments in the production of this furnace injured his health and for a time laid him off work altogether, yet the invention has been allowed to lie dormant. Probably his converter might have shared the same fate if he had not had the energy and resolution to work it himself.

Great as his services have been in the promotion of industry and in the application of the powers and principles of nature to the purposes and prosperity of man, his career of usefulness and invention is not yet ended. He is now engaged on the construction of a telescope which will be more manageable and more powerful than any in existence. After carefully studying the works of Herschel, Sir Henry Bessemer is now engaged in applying by novel mechanical contrivances some of the principles in optics which are therein enunciated, but which have never hitherto been realized in the observatory. Besides a great increase in visual power being expected, the effectiveness of the new instrument will be immensely increased by mechanical appliances whereby it is capable of being directed to any part of the heavens at will, without either waiting for the earth's motion, as the great Rosse telescope has to do, or for the assistance of any one but himself, so that any time of the night he can survey the stellar world without climbing up long ladders or lying on his back in an uncomfortable or constrained position. The observing room, with its floor, windows, and dome are made to revolve and keep pace automatically with every motion of the instrument, which, however, is detached from the moving parts of the building and is firmly fixed on a massive foundation of iron, masonry, and concrete. The observer can sit or stand in an upright position in the center of the floor, looking straight before him into the eyepiece, which is placed 5½ feet above the floor. The upper end of the telescope reaches a height of 45 ft. perpendicular from the foundation. It is confidently expected that this instrument will not only be by far the most wonderful yet made, but will embody principles of construction that will make it the forerunner of cheaper and still more powerful telescopes than have ever yet been attempted. It will probably be completed in twelve months hence.—*Universal Engineer.*

CARLISLE CATHEDRAL.

THE ancient Britons had their town of Caer Luel, in their principality of Cumbria or Strathclyde, before the Roman conquest. Lugubalia was the name which the Romans bestowed on this place. It was occupied by the Anglians of Northumbria, but in the latter Saxon reigns was utterly laid waste by piratical Norsemen. William the Norman and his successors restored the city; and a college of Augustinian monks, with a church of St. Mary, was founded here by Henry I. The Bishopric of Carlisle was established in 1133, but little remains of the Norman cathedral building, only the south transept, a part of the nave, and some piers of the central tower. (See engraving opposite.)

The general aspect of Carlisle Cathedral is pleasing, and, viewed from the churchyard of Stanwix, a suburb on the lower ground to the northward of the city, across the river Eden, it has considerable dignity, being situated on rising ground, with Carlisle Castle not far above it. The building is chiefly of dark red sandstone, which color forms an agreeable combination with the surrounding verdure of trees and greensward; but there are tall factory chimneys and an obtrusive large railway station in close vicinity to the ecclesiastical precinct. The distant Cumberland "fells," or mountainous moors, afford a noble background to this view.

It is believed that the Early English choir, of the thirteenth century, was begun about 1218 by Bishop Hugh of Beaulieu, who had been Abbot of Beaulieu in Hampshire. Its present interior details of architecture, the original work having been destroyed by fire in 1292, are of the Decorated style, and are ascribed to Bishops Welton and Appleby, in the latter part of the fourteenth century. The east window is esteemed one of the most beautiful in the world, surpassing even the south window of the great transept in Lincoln Cathedral, and the west windows of York and Durham. Its tracery framework is of exquisite design, perfect in grace and symmetry; the stained glass pictures, made in the reign of Richard II., in the upper lights of this window, represent the Resurrection, the Last Judgment, and the New Jerusalem. There is some modern stained glass in the lower part, supplied as a memorial to Bishop Percy in 1856.

The Bishops of Carlisle were never of great political importance, being overshadowed by the princely magnificence of the neighboring Bishops of Durham. But several of them have been men of repute for learning and piety; and it has always been a highly respectable See.—*Illustrated London News.*

SHEARING STRENGTH OF SOME TIMBERS.

THE article on this subject given in our SUPPLEMENT, No. 242, was from the Journal of the Franklin Institute.

THE FABRICATION OF AINO CLOTH.

By PROF. D. P. PENHALLOW.

IN view of the very uncertain history of the Ainos, it is difficult to obtain reliable information respecting the origin of any of the rude arts with which they appear to be familiar. According to the testimony of the Ainos themselves, weaving has been practiced by them from very early times, while their traditions also state that their knowledge of the art was original and not obtained from the Chinese or Japanese. There appears but little either in support or contradiction of such statements other than can be obtained by a comparison of the machines used by the Ainos and their Japanese neighbors. Those used by the former involve a simplicity not to be found in any of the Japanese instruments, pointing to originality or marked deterioration in the first case, or, in the second, a greater improvement of original forms than has generally been recognized as a feature of the old style of mechanical ingenuity. While the whole subject is involved in its present obscurity, we can only look upon the statements of the Ainos as of traditional interest.

The fabrication of the cloth involves processes and implements of the greatest simplicity, such as may readily be executed or procured under the conditions of a wild forest life. The material used is course bast fiber obtained from two species of elm, *Ulmus campestris* and *U. montana*, respectively known to the Ainos as Akădamo and Ohĭyo. The slight maceration or simple bruising to which the fiber is subjected results in nothing more than a separation of the various bast layers, no attempt being made to separate individual fibers and produce twisted threads; hence we find the prepared material very coarse, and the finished product correspondingly so.

As a class, the Ainos are not yet susceptible to the demands of higher and increasing wants. Their desires are few, of a low order, and easily satisfied; and in the matter of clothing, it is sufficient for them to know and feel that their one garment satisfies the demands of decency, that the material costs only the expenditure of time—which, to them, is nothing—and that the processes of preparation and fabrication are both simple and easily accomplished. Delicacy of touch, pliability, fine texture, and a pure color are considerations which do not find place in the Aino mind, yet with an exhibition of the truly savage taste which delights in a display of rude and brilliant ornamentation, we find them expending great effort upon their garments to secure striking, if not altogether symmetrical and harmonious decoration.

The collection and preparation of fiber, though properly belonging to the women, is not unfrequently undertaken by the men in connection with their own peculiar work. Thus with a hunting expedition, which may last several days, they often combine the object of collecting bark, either for cloth or the manufacture of ropes; while their visits to pools where the bark is macerating will be combined with a search for their principal source of farinaceous food—lily bulbs.

The bark is generally drawn from the standing tree. Three or four good blows with the heavy knife, which every man carries, suffice to permit a good hold with both hands, when, by the exercise of a little skill, a strip of bark nearly a foot wide is drawn off quite up to the branches, often a distance of twenty feet. If taken from the Ohiyo it is macerated for about ten days in quiet pools of tepid water, such as are common about the borders of swamp lands. As soon as sufficiently macerated the outer bark readily separates from the bast portion, when this latter is again split into long and broad strips, usually about ten in number. These are then dried slowly to prevent rendering the fiber brittle, after which they are stripped into threads having an average width of one-eighth of an inch. No twisting or other process is performed, but as soon as the threads (*Ah*) have been made of the proper size they are joined together by a simple square

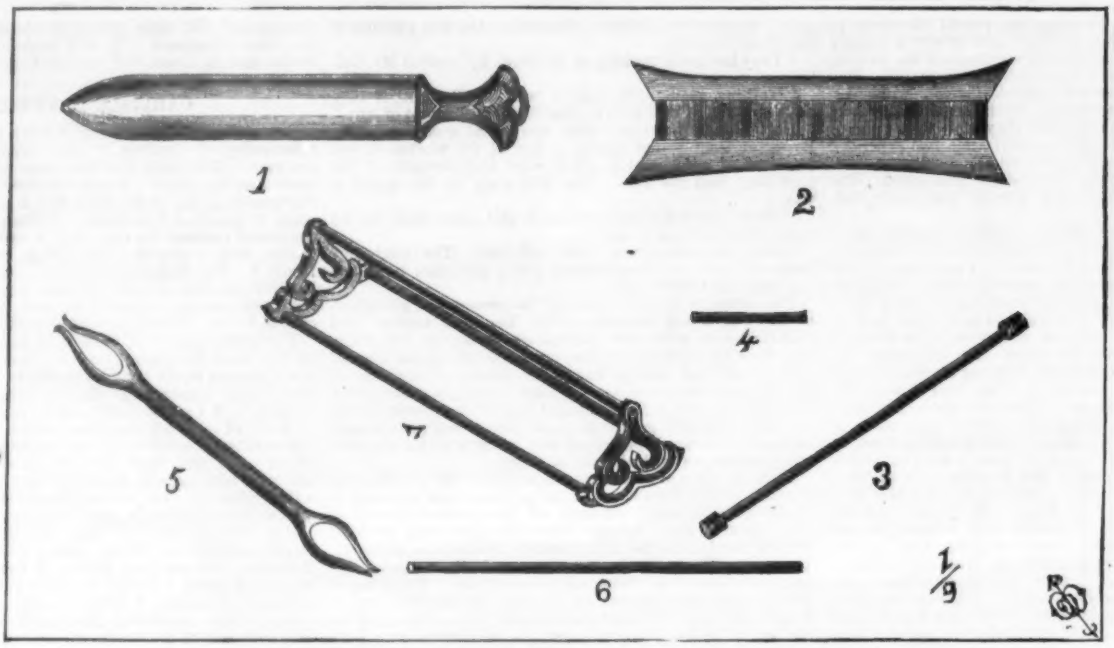


PLATE 1.—INSTRUMENTS USED IN WEAVING AINO CLOTH.

knot and nicely wound in balls five inches in diameter, which unwind from the interior.

The bark of the Akădamo is not macerated, but as soon as gathered the outer bark is separated from the bast. The latter, in strips about three inches wide, is repeatedly doubled and thoroughly broken by the *teeth* at the point of folding. By this means it is soon possible to separate the various layers of bast without any difficulty. The subsequent treatment is the same as of the Ohiyo bark.

The instruments employed in weaving are but seven in number, and, while they are of great simplicity, they seem quite efficient for the class of work demanded. They may be enumerated as follows:

No. 1. Be'ra.
" 2. O'sha.
" 3. Be'kofune.
" 4. Ada'te.
" 5. Aho'nishi.
" 6. Yo'dosini.
" 7. Ga'masa.

With the exception of the bera, which is usually maple, all the implements are made of some soft wood, such as pine. The only instrument used for making and carving them is a small sheath knife, having a slightly curved blade about six inches in length. Oftentimes the Aino will call into requisition all his skill in carving to produce an elaborate set of instruments, while in the majority of cases they are left quite plain. The general forms and sizes will be understood from the accompanying figures. With the exception of Figs. 1, 3, 7, the instruments are perfectly plain. In the ŏsha (Fig. 2), the bars are of such number as to admit the use of one hundred and sixty-five warp threads. The bera is used only for the purpose of tightening the threads. The ahonishi, or shuttle, usually holds enough thread to complete about three feet of cloth.

To prepare the threads for the loom, several sticks one foot long are driven into the ground, constituting the house floor, arranged as shown in Plate 2, from 1–7. The number and distance apart vary according to the length of the threads to be used, consequently of the cloth to be made. Two balls of thread, prepared as previously described, are then selected and unwound together, thus greatly facilitating the operation. The threads start at 1, turn 2, and pass around peg 1 again, thence to 4–3, and so on; when, after passing the last peg, 5, they return over the same course to 1. This process is repeated until, without counting, the operator thinks she has enough threads to fill the loom. Between pegs 5 and 6 the threads are crossed each time by a simple twist, as shown at *a*, and secured by a side peg, 7. Thus is accomplished the crossing which, later, serves to separate the woof threads.

The proper number of threads obtained, they are tied at various intervals, a strip of bark is passed each side of the cross at *a*—shown more distinctly at *a*', Fig. 5'—to keep the threads from uncrossing, and the loop at 2, shown in Fig. 2', is well wound to keep the threads of each series distinct. The pegs are then drawn, and the operator has a single bundle of threads with a loop at each end. The loop of each thread at 5 is then passed through the ŏsha, so that the latter will be between the crossing, *a*', and the longer portion of the threads. The yŏdosini is next passed through the loop 5, and serves to keep the threads in position, as well as a straining stick by which the warp may be kept at proper tension. At a distance of four or five feet from the ŏsha, the ădate is secured to the threads and passed through a looped string fastened to some firm object. By means of a string passing around the body, and secured to each end of the yŏdosini, the operator, who sits upon the floor, can easily regulate the tension of the threads by bringing all strain upon the ădate. The gămasa is placed within a few inches of the ŏsha, but between it and the cross of the threads; its only use is to properly separate the upper and lower series of threads, to permit the action of the ăhonishi. The bekofune occupies a position near the gămasa, about one-half way between it and the yŏdosini. Small twine is then passed over it and looped under each warp thread of the lower series, thus forming a simple means of bringing either series of threads to the top, and varying the cross of the warp to correspond with the movement of the ăhonishi. The position of parts will be readily understood from an inspection of Plate 3.* (Next page.)

The size of the cloth is quite variable, since the Ainos seldom count and have no means of accurate measurement. Thus if, in stretching the warp threads, the operator obtains more than enough to fill the loom, the extra ones are dropped out, and the cloth will have a maximum width of 13.5 inches. If, however, not enough threads were taken to fill the loom, no more are added. The usual length of the cloth is six and a half times the length of the expanded arms, and as this latter will average five feet, we find the total length of cloth approximating thirty-two feet in round numbers.

After the thread has been prepared, such a piece of cloth can be made in from three to four days, according to the skill of the operator, who is always a woman.

The color of the finished fabric is always that of the bark from which it is made, though uniformity is rare, owing to discoloration of the threads during preparation. If made from Ohiyo, the color is usually brown, with slight inclination to red, while that made from the Akădamo is invariably of a bright tan color.

As an article of clothing, for which use alone it appears to be utilized, the Aino cloth has several good qualities. It is very coarse in texture, as would be expected from the nature of the material, but it possesses great strength and wears out slowly; while its meshes are so close and the threads so compact that it is completely proof against ordinary rains, on which account the Japanese make great use of it for rain coats.

Ainos make yet another kind of cloth out of fiber obtained from a species of *Urtica*. This, however, is only made in small quantities, since its use is restricted to burial purposes.

The garments are made in the most simple manner, the breadths being cut without any bias. Nearly all are ornamented with some simple figure, either blue or white, though red and green are not unfrequently used. Plate 3 will show some of the most characteristic patterns, which were copied from the dress of a chief's wife, and are very good representations of the more elaborate forms.

In addition to the buskins the only garment worn is a coat reaching somewhat below the knees and fastened at the waist by a girdle. Upon this one garment the women often lavish all their skill in decorating, and thus the coats of chiefs—more especially their wives and children—not unfrequently make a great display of gaudy trimming. The ornamentation, however, often lacks greatly in symmetry, as can be seen by the figures.—*American Naturalist.*

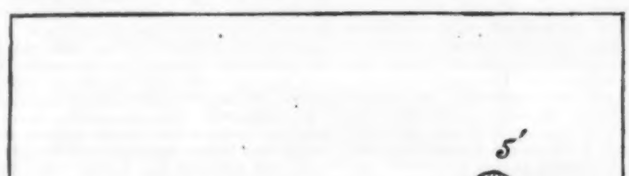


PLATE 2.—METHOD OF STRETCHING AND TYING WARP THREADS.

* EXPLANATION OF PLATE 3.—1. Gamasa. 2. Osha. 3. Bekofune. 4. Yodosini. 5. Adate. 6. Position of operator. *a*, Cross of threads = *a*', Plate 2. A. Pattern for front skirt of coat. B. Pattern for collar. C. Pattern for cuff.

THE London *Daily News* remarks upon the startling fact that the entire wheat crop of the British Isles, on the three million acres devoted to it this year, will have a total value just about enough to meet the cost of the Afghan war up to midsummer. Since then most of what had been gained in that unconquerable country has been lost through the defeat of Gen. Roberts.

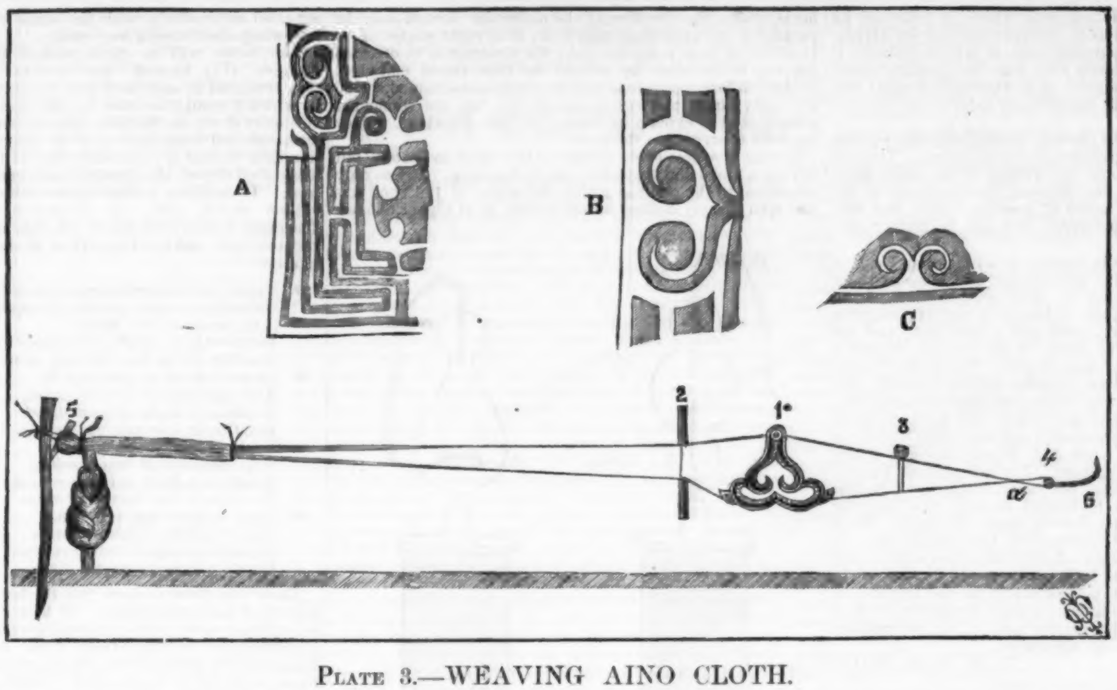


PLATE 3.—WEAVING AINO CLOTH.

AN EVENING WITH FASOLDT'S 1,000,000 TEST PLATE.

OF course we scarcely hope to resolve the whole forty-one bands of this magnificent plate, the product of a new machine constructed by Mr. Fasoldt expressly for the execution of fine ruling, and capable of dividing an inch into 10,000,000 parts. In order, however, to assure ourselves that the lines are really there, and cleanly cut, and only awaiting sufficient power to be fully resolved, we close the aperture in the diaphragm, put on a Spencer inch of 30°, place our lamp—which we prefer to daylight—7 or 8 inches from the center of the stage, and about 3 inches above and the same behind its horizontal axis. Now with a thin card under the clips we so adjust the condenser that a narrow, very narrow, image of the flame's edge is projected upon the card directly across the field of view. For this purpose an ordinary double convex lens of 2 or 2·5 inches focus is as good as most condensers, and a great deal better than some.

Having obtained a satisfactory pencil of light, we remove the card, substitute the rulings, and are rewarded for our painstaking by a sight which is not given every one to see. The whole forty-one bands are in the field, with sparkling lines of brilliant spectra occupying seven of the lower bands, the red rays being refracted by the 30,000 band, orange, yellow, green, blue, and indigo succeeding each other, upon each succeeding band (which is so very near the number of undulations per inch, for color, as given by Herschel, that we are almost tempted to turn aside for a moment) to the 60,000 band, which shows a dark violet; and this color, inclining a little to gray, and broken only by the golden brown of the division lines, extends throughout the remaining bands to the 1,000,000, with a regularity which, considered as the result of human effort, is simply marvelous, but which, taken in its optical connection, shows that the lines do exist in a perfect state; it being very evident that the least fault would cause a break in the sequence of color, we thus establish the most conspicuous feature in the entire plate. One glimpse exhibits this convincing fact with greater force than a whole volume of declarations.

After the million band we find three additional bands, called test bands, ruled in 50,000 lines to the inch, with division lines between them, and all three presenting the brilliant green of the solar spectrum in strong contrast with the dark violet of the higher bands and the lively brown of the division lines.

We now exchange the inch objective for an eighth of 175°, same maker, immersed in water, with a little glycerine added, remove the diaphragm and condenser, lower the lamp to a trifle below the level of the stage, and move it a little in front, with the edge of the flame still towards the mirror, and pushing the mirror up to an obliquity of 175°, or more, if the construction will permit, project a thin, sharp, well-defined pencil of light through the bottom of the plate at right angles to the lines, which done, we may consider ourselves well on the way to success.

Naturally we are curious to examine the test bands before anything else, partly because they are a new invention, and partly because we hardly expect to see the lines they represent.

The lines in the first of these test bands are cut of the same breadth and depth as those of the twenty-sixth or quarter million band, but as they are only 50,000 to the inch instead of 250,000, we easily resolve them, and see exactly of what the 250,000 band is composed. We now move along over the division line between the first and second test bands. These division lines, cut very much broader and deeper than any other lines on the plate, are also a new feature introduced by Mr. Fasoldt, and serve, like milestones, to mark the space passed over, thus saving time and facilitating in many ways the operations of the observer.

The lines of the second test band are cut the same as those of the thirty-fourth or half a million band; and although possessing the same value as those of the first test band, they are very much finer, and, by consequence, not quite so easily found. We get them, however, with a beautiful fine black line at the bottom of the cut, and are now, if we have not been before, well satisfied of the existence of distinct, clean cut lines in the half million band. We now attack the third test band, which, like the others, has its lines the 50,000th of an inch apart, but of the same cut as the million band, and are only about one-half as broad and deep as the last we examined, and a little patience and nice manipulation are required to bring them into focus. We see them at last, however, infinitesimal as they are, and render at once our word of praise to the genius who dared not only to project, but to execute, a test so many years in advance of microscopical science.

With all our adjustments undisturbed, we move the plate to the beginning, or 5,000 band, and are struck with the marked difference in the appearance of these lines as compared with those we have just examined, a difference which, thoroughly understood, goes far of itself to establish the possibility of ruling the million band. But we pass rapidly on to the 60,000 band, stopping only to admire the uniform regularity of the ruling, and the fine, sharp, black lines at the bottom of the cut, resulting from a refinement of execution peculiar to work of this description.

The 70,000 demands greater care and a little readjustment of focus or illumination, during which process we notice the beautiful pink color lying at the bottom of the division lines, which seems to indicate that good work is being done.

For the 80,000 we apply a Woodward prism, gaining by this means a greater obliquity of light, sufficient to show the 80,000 nicely, and gives us a glimpse of the 90,000, when, considering that the eighth has accomplished all that can be expected from it, we relieve it from further duty, and another evening will take up the one-sixteenth, simply remarking that the results this evening have been obtained, with neither fuss nor paraphernalia, from resources ordinarily at hand.—*F. S. Burrell, in Amer. Jour. of Microscopy.*

RESPIRATION AT VARIOUS ALTITUDES ON THE ISLAND AND PEAK OF TENERIFFE.

By W. MARCET.

THE experiments were performed by the author on himself and his guide at three stations, respectively 7,090, 10,700, and 12,200 feet above the sea-level. The functions investigated were the number of respirations, the volume of air, amount of carbonic acid, and amount of water expired per minute at the three stations, both while at rest and while doing a definite amount of work. By the comparison of the results with those obtained in a previous series of experiments on the Alps, the effects of increased temperature were determined.

The results obtained may be summarized as follows:

The carbonic acid expired is, under all circumstances, proportional to the weight of the body; for the subjects of these experiments it was 676 mgrms. per 100 kilos. The amount was greatest during the first or second hour after eating, afterwards gradually diminishing.

The amount of carbonic acid expired was greater at Teneriffe than on the Alps, the increase amounting to 14·0 and 17·5 per cent. for the author and his guide respectively. There was no increase in one case at the greater elevations such as was experienced on the Alps, the increase in the latter case being probably due to reduced temperature. In the other case, however, 17 per cent. more carbonic acid was expired at the sea-level than on the Peak of Teneriffe. This was due to increased perspiration on the higher altitudes.

The volume of air expired per minute, and also the number of respirations, decreased at the higher elevations. The percentage of carbonic acid in the air expired increased from 4·1 per cent. at the sea-level to 4·9 per cent. at 11,945 feet.

With respect to the effect of work, it was found that the relation between the *volumes* of air expired while sitting and while engaged on a regulated amount of muscular work, was the same as the relation between the *weights* of carbonic acid expired under such circumstances.

The amount of water expired increases considerably from the lower to the higher level; this causes a very great loss of heat at the higher elevation.—*Proc. Roy. Soc.*

THE MICROSCOPE IN WRITING.

THE examination of hand-writing, with a view to determine its authorship, its genuineness, its age, and whether or not it has been altered from its original form and intent, is one of the more recent uses of our microscope, and one the importance, reliability, and frequent applicability of which has but recently become known, and is even now not generally realized. Perhaps this is to be accounted for by the fact that large general experience, judgment, and tact in the use of the instrument and skill in the manipulation, though necessary to this particular work, are not, in themselves, an adequate preparation for it. Much special study and special practice are required before anything useful can be done or important should be attempted. But to a person really at home in the study of hand-writing, both with and without the microscope, this instrument furnishes a ready means for its accurate analysis. Those who are governed, not by respect for the rights of others, but only by the expectation of consequences that shall affect themselves, cannot learn too soon, or too well, the fact that writing can scarcely be changed, after its original execution, so adroitly that the microscope cannot detect the falsification. The face of the paper when once marred, by disturbing the position of the fibers, can never be restored; and hence scratching and erasure can be recognized, though performed with consummate skill, and not distinguishable by other means. Inks which are alike to the unaided eye are marked under the lenses by conspicuous differences of shade or color, or density or purity, or chemical composition. Lines which look simple and honest may show themselves as retouched or altered by the same or by different hand or pen or ink; and lines drawn upon new paper may look different from those drawn after it is old.

The microscope does not give any direct information as to the precise age of writing, but if used with sufficient caution it can determine (not so easy or safe a task as might be supposed) the relative age of superposed, crossing, or touching lines; and it can generally state positively whether lines were written before or after related erasures, or scratchings, or foldings, or crumplings of the paper.

In one important case my friend, Mr. Wm. E. Hagan, of Troy, who has given extensive and very successful attention to the study of writing, especially imitative writing, and in association with whom many of my own investigations in this field during the last dozen years have been carried on, established the date of the document by recognizing in the paper fibers which had only recently been used in paper making, and which, in connection with corroborative proofs to which they led, demonstrated that the paper was manufactured at a later date than that claimed by the writing upon it.

To discuss the subject of imitative writing would require the opportunities of a book, not of a fraction of a lecture; and many considerations of recognized importance connected with it are still under investigation and not sufficiently mature for publication. A few hints may be given in respect to those points which are well established and most generally applicable. When a word, in a fictitious signature, for instance, has been constructed by tracing it with pencil lines over an original one, and subsequently inking it over with a pen, particles of plumbago can probably be somewhere detected and recognized by their position and their well-known color and luster. The mechanical effect of the point of a pencil upon and among the fibers of the paper can also be seen, notwithstanding the subsequent staining of the paper by the ink. This clumsy method of copying carries its own means of detection, and still it is not more easily recognized than are methods that are more subtle and seem more dangerous.

In writing copied or imitated originally in ink, either by tracing it over a copy or by drawing it free-hand with a copy to inspect or to remember, the distribution of ink is peculiar and suggestive, indicating hesitation from uncertainty, or pauses to look at a copy, or to recall a style, or to decide as to a future course, just at points where a person writing automatically by his own method, and especially in writing his own name or a scarcely less familiar business formula, would pass over the paper most rapidly and promptly.

Again, there are certain ear-marks, results of habits, which finally become as natural as it is to breathe, and which characterize the writing of different individuals. Such are peculiar forms and styles of letters and of combinations of letters; methods of beginning or of ending lines, letters, words, or sentences; methods and places of shading or breaking lines, and of dotting, crossing, patching, or correcting; habits of correcting or not correcting certain errors or omissions; the use of flourishes; and peculiar ways of connecting words or of dissociating syllables. In imitative writing these ear-marks of another ownership are generally copied with ostentatious prominence, if not with real exaggeration, in the capital letters and other prominent parts, but lost sight of in those less conspicuous places where imitation naturally becomes feeble and the habit of the writer unconsciously asserts itself; and this revelation often becomes more positive by reason of the elaborate efforts that are made to suppress it. Things are overdone from fear, which would have been negligently done from habit, not to speak of gross blunders proceeding from the same source. I once examined a disputed signature from which had been carefully scratched out a line, immaterial and inconspicuous, which conformed to the habit of another person interested in the case, but not to the habit of the ostensible author of the writing.

Furthermore, the genuineness of a writing may often be

disproved by the very success with which it followed its copy, reproducing its mistakes, idiosyncrasies, or its adaptations to its own special surroundings, in which respects it may correspond too accurately with some one genuine signature (in the hands, for instance, of a suspected person), but differ unquestionably from the ordinary habit of the reputed author.

Modifications of style by disease, as paralysis, may present similarly decisive discrepancies or coincidences. There is a peculiar tremor, too, about the writing of an individual, which is dependent on the physical conformation of the writer as related to his habits of position, touch, and motion, which is quite characteristic, as it can be neither imitated nor concealed.

All these investigations in respect to writing can be best pursued with the aid of the microscope, and some of them are entirely dependent upon it. For general view of the words a four or three inch objective is best adapted; for special study of the letters, a one and a half inch; and for minute investigation of the nature of the lines or character of the ink, a two thirds or four-tenths. The lenses except the last should be of the largest angles ordinarily made, and all should be of flat field and of the best possible definition. The microscope stand should have a large, flat stage, though it is generally preferable to use a small portable stand which can be moved freely over the paper and focused upon it at any point without the use of a stage. For this purpose I sometimes use a tank microscope, but more frequently a pocket microscope, with its tube prolonged through the stage by adapters, so that it focuses directly upon the table. Even so large an instrument as Zentmayer's histological may be so used to advantage, though a lighter form and smaller size is far more convenient and sufficiently steady for this work. A medium-sized bull's eye is sufficient for the purpose of illumination, and good judgment is more important than, if not incompatible with, the employment of an ostentatious and unnecessarily elaborate apparatus.

R. H. WARD, M.D.

CONTRIBUTIONS TO MOLECULAR PHYSICS IN HIGH VACUA.*

IT has been shown that the stream of molecules are shot off from the negative pole in a negatively charged condition, and their velocity is owing to the mutual repulsion between the similarly electrified pole and molecules. It became of interest to ascertain whether lateral repulsion was exerted between the molecules themselves. If the stream of molecules coming from the negative pole carried an electric current, two parallel rays should exert mutual attraction; but if nothing of the nature of an electric current was carried by the stream, it was likely that the two parallel rays would act simply as negatively electrified bodies and exert lateral repulsion. This was not difficult to put to the test of experiment.

A tube was made with two flat aluminum terminals, *a b*, close together at one end, and one terminal, *c*, at the other, as shown in Fig. 11. Along the center of the tube, cutting

FIG. 11.

FIG. 12.

the axis obliquely, is a screen of mica, painted over with a phosphorescent powder, and between the screen and the double poles, *a b*, is a disk of mica crossing the axis of the tube, and therefore nearly at right angles to the phosphorescent screen. In this mica disk are two slits—one opposite each pole *a* and *b*—running in such a direction that the molecular streams emanating from *a* and *b* when made negative shall pass through the slits, forming two horizontal sheets. These sheets striking against the oblique screen will be made evident as two horizontal lines of light. The poles *a* and *b* were somewhat bent, so that the lines of light were not quite parallel, but slightly converged. The tube being properly exhausted, the pole, *a*, was made negative and *c* positive, the lower pole, *b*, being left idle. A sharp ray of phosphorescent light shot across the screen along the line, *d f*. The negative wire was now transferred from *a* to *b*, when a ray of light shot along the screen from *e* to *f*. The two poles, *a* and *b*, were now connected by a wire, and the two together were made the negative pole. Two lines of light now shone on the screen, but their positions, instead of being, as before, *d f* and *e f*, were now *d g* and *e h*, as shown by the dotted lines. The wire joining the poles, *a b*, was removed, and the pole, *a*, made negative; the ray from it followed the line, *d f*, as before. While the coil was working, another wire hanging loose from the pole, *b*, was brought up to *a*, so as to make them both negative. Instantly the ray, *e h*, shot across the screen, and simultaneously the ray, *d f*, shifted its position up to *d g*. The same phenomena were observed when the pole, *b*, was connected with the coil, and contact was alternately made and broken with *a*; as the ray, *d g*, shot across, the ray, *e f*, dipped to *e h*.

These experiments show that two parallel rays of molecules issuing from the negative pole exert lateral *repulsion*, acting like adjacent streams of similarly electrified bodies. Had they carried an electric current they should have attracted each other, unless, indeed, the attraction in this case was not strong enough to overcome the repulsion.

Many experiments have been made to ascertain the law of the action of magnets, and of wires carrying currents, on the stream of molecules.

As an indicator, a small tube, as shown in Fig. 12, was employed. The two poles are at *a* and *b*, *a* being the negative. At *c* is a plate of mica with a hole in its center, and at *d* is a phosphorescent screen. A sharp image of the hole in the mica is projected on the center of *d*, and the approach of a magnet causes this bright spot to move to different parts of the phosphorescent screen.

A large electro-magnet was used, actuated by two Grove cells, and the indicator tube was carried round the magnet in different positions and the results noted. The molecular stream when under no magnetic influence passes along the axis of the tube, as shown by the small arrow (Fig. 12). It will be seen that the indicator can occupy three different directions in respect to the magnet. The magnet being held horizontally, the direction of the molecular stream may be parallel to the axis, tangential to it, or at right angles to it. In either of these positions, also, the stream may be directed one way or the other (by turning the tube round endwise). In these different positions various results are obtained, which are easily illustrated with a solid model, but are somewhat complicated to explain by means of flat drawings. They are fully described in the paper.

A long tube was made similar to the small indicator, but having a molecular trajectory six inches long. It was only exhausted to the point at which the image of the spot was just seen sharply defined on the screen, as at higher exhaus-

FIG. 13. FIG. 14.

tions the action of magnetism is less. The phosphorescent screen was divided into squares for convenience of noting the deflection of the spot of light. So sensitive was this to magnetic influence, that when the tube was placed parallel to the earth's equator the earth's magnetism was sufficient to cause the spot to move five millims. away from the position it occupied when parallel to the dipping needle (in which position the earth's magnetism did not appear to act). When held equatorially and rotated on its axis, the spot of light, being always driven in one direction, independent of the rotation of the tube, appeared to travel round its normal position in a circle of ten millims. diameter.

I have long tried to obtain continuous rotation of the molecular rays under magnetic influence, analogous to the well known rotation obtained at lower exhaustions. Many circumstances had led me to think that such rotation could be effected. After many failures an apparatus was constructed as follows, which gave the desired results:

A bulb (Fig. 13) was blown of German glass, and a smaller bulb was connected to each end of the larger bulb by an open very short neck. At each extremity was a long aluminum pole projecting partly into the large bulb and turned conical at the end. After good exhaustion the passage of an induction current through this apparatus fills the center bulb with a very fine green light, while the neck surrounding the pole which happens to be negative is covered with two or three dark and bright patches in constant motion, following each other round first one way and then the other, constantly changing direction and velocity, sometimes dividing into other patches, and at others fusing together into one. After a little time, probably owing to the magnetism of the earth, or that of the core of the induction coil not far off, the movements sometimes become more regular,

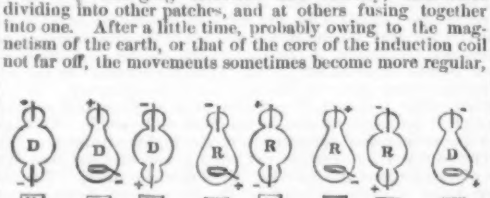


FIG. 15.

and slow rotation takes place. The patches of light concentrate into two or three, and the green light in the bulb gets more intense along two opposite lines joining the poles forming two faintly outlined patches, which slowly move round the bulb equatorially, following each other a semi-circumference apart.

An electro-magnet placed beneath in a line with the terminals (Fig. 13) converts these undecided movements into one of orderly rotation, which keeps up as long as the coil and magnet are at work.

In order to compare accurately the behavior of the molecular streams at high exhaustions with that of the ordinary discharge through a moderately rarefied gas, another tube was taken having the upper pole an aluminum wire, and the lower one a ring (Fig. 14). It was only exhausted to such a point that the induction spark should pass freely from one pole to the other in the form of a luminous band of light, this being the form of discharge usually considered most sensitive to magnetic influence. This tube was also mounted over an electro-magnet, and the two sets of apparatus being actuated successively with the same coil and battery, the following observations were made.

The tubes will be distinguished by the terms "high vacuum" (Fig. 13) and "low vacuum" (Fig. 14). The rotation produced in each tube will be recorded in the direction in which it would be seen by an observer above, looking vertically down on the tube, his eye being in a line with the terminals and with the axis of the magnet. When the rotation thus viewed is in the direction of the hands of a watch it is called *direct;* the opposite movement being called *reverse.* To facilitate a clear appreciation of the actions, an outline sketch (Fig. 15) accompanies each experiment. The shape of the tube shows whether it is the high or low vacuum tube, and the letter D or R shows the direction of rotation.

a. Upper pole of electro-magnets *north.*
Induction current passing through tubes so as to make the top electrode *positive.*
Rotation in the high vacuum *direct.*
Rotation in the low vacuum *direct.*

b. Upper pole of magnets *north.*
Top electrode of tubes *negative.*
Rotation in high vacuum *direct.*
Rotation in low vacuum *reverse.*

c. Upper pole of magnets *south.*
Top electrode of tubes *positive.*
Rotation in high vacuum *reverse.*
Rotation in low vacuum *reverse.*

d. Upper pole of magnet *south.*
Top electrode of tubes *negative.*
Rotation in high vacuum *reverse.*
Rotation in low vacuum *direct.*

These experiments show that the law is not the same at high as at low exhaustions. At high exhaustions the magnet acts the same on the molecules whether they are coming to the magnet or going from it, the direction of rotation being entirely governed by the magnetic pole presented to them, as shown in cases *a* and *b* where the north pole rotates the molecular stream in a *direct* sense, although in one case the top electrode is positive and in the other negative. Cases *c* and *d* are similar; here the magnetic pole being changed, the direction of rotation changes also. The direction of rotation impressed on the molecules by a magnetic pole is opposite to the direction of the electric current circulating round the magnet.

The magnetic rotations in low vacua are not only fainter than in high vacua, but they depend as much on the direction in which the induction spark passes through the rarefied atmosphere as upon the pole of the magnet presented to it. The luminous discharge connecting the positive and negative electrode carries a current, and the rotation is governed by the mutual action of the magnet on the perfectly flexible conductor formed by the discharge.

In high vacua, however, the law is not the same, for in cases *b* and *d* similar arrangements produce opposite rotations in high and in low vacua. The deflection exerted by a magnet on the molecular stream in a high vacuum may be compared to the action of a strong wind blowing across the line of fire from a mitrailleuse. The deflection is independent of the to-and-fro direction of the bullets, and depends entirely upon the direction of the wind.

I have already mentioned that platinum will fuse in the focus of converging molecular rays projected from a concave pole. If a brush of very fine iridio-platinum wire, which has a much higher fusing point than platinum, be used to receive the molecular bombardment, a brilliant light is produced, which might perhaps be utilized.

A piece of apparatus was constructed in which a plate of German glass was held in the focus of the molecular bombardment. The vacuum was so good that no hydrogen or other lines could be seen in the spectrum of the emitted light. The focus was now allowed to play on the glass, when the glass soon became red hot. Gas appeared in the tube, and hydrogen lines now were visible in the spectrum. The gas was pumped out until hydrogen disappeared from the spectrum. It was now possible to heat the glass to dull redness without hydrogen coming in the tube; but as soon as the heat approached the fusing point the characteristic lines appeared. It was found that however highly I heated the glass and then pumped the tube free from hydrogen, I had only to heat the glass to a still higher temperature to get a hydrogen spectrum in the tube. I consider the hydrogen comes from vapor of water, which is obstinately held in the superficial pores, and which is not entirely driven off by anything short of actual fusion of the glass. The bubbles noticed when the disintegrated and fused surface of the tube was examined under the microscope are probably caused by escaping vapor of water.

When the negative discharge has been playing for some time on German glass, so as to render it strongly phosphorescent, the intensity of glow gradually diminishes. Some of this decline is due to the heating of the glass or to some other temporary action, for the glass partially recovers its property after rest; some is due to a superficial change of the surface of the glass; but part of the diminished sensitiveness is due to the surface of the glass becoming coated with this brown stain.

The luminous image of a hole in a plate of mica was projected from a *platinum* plate used as a negative pole to the side of a glass bulb. The coil was kept playing for some time until the inside of the bulb was thoroughly darkened by projected platinum. Although a bundle of molecular rays could be seen all the time passing from the platinum through the hole in the mica to the glass, where it shone with a bright green light, I could detect no trace of extra darkening when the part of the glass formerly occupied by the green spot was carefully examined. Platinum is a metal which flies off in a remarkable manner when it forms the negative pole. It therefore appears from this experiment that the molecular stream does not consist of particles of the negative pole shot off from it.

One of the most striking of the phenomena attending this research has been the remarkable power which the molecular rays in a high vacuum possess of causing phosphorescence in bodies on which they fall. Substances known to be phosphorescent under ordinary circumstances shine with great splendor when subjected to the negative discharge in a high vacuum. Thus, a preparation of sulphide of calcium, much used now in Paris for coating clock faces which remain luminous after dark, is invaluable in these researches for the preparation of phosphorescent screens whereon to trace the paths and trajectories of the molecules. It shines with a bright blue violet light, and when on a surface of several square inches is sufficient to light up a room. Modifications of these phosphorescent sulphides shine with a yellow, orange, and green light.

The only body I have yet met with which surpasses the luminous sulphides both in brilliancy and variety of color is

* "Contributions to Molecular Physics in High Vacua. Magnetic Deflection of Molecular Trajectory; Laws of Magnetic Rotation in High and Low Vacua; Phosphorogenic Properties of Molecular Discharge." By William Crookes, F.R.S. (Extracts from a paper in the "Philosophical Transactions" of the Royal Society, Part 2, 1879.)

the diamond. Most of these gems, whether cut or in the rough, when coming from the South African fields, phosphoresce of a brilliant light blue color. Diamonds from other localities shine with different colors, such as bright blue, pale blue, apricot, red, yellowish green, orange, and bright green. One beautiful green diamond in my collection when phosphorescing in a good vacuum gives almost as much light as a candle; the light is pale green—almost white. A beautiful collection of diamond crystals kindly lent me by Prof. Maskelyne phosphoresce with nearly all the colors of the rainbow, the different faces glowing with different shades of color.

Next to the diamond, alumina in the form of ruby is perhaps the most strikingly phosphorescent stone I have examined. It glows with a rich full red, and a remarkable feature is that it is of little consequence what degree of color the earth or stone possesses naturally, the color of the phosphorescence is nearly the same in all cases; chemically precipitated amorphous alumina, rubies of a pale reddish yellow, and gems of the prized "pigeon's blood" color, glowing alike in the vacuum, thus corroborating E. Becquerel's results on the action of light on alumina and its compounds in the phosphoroscope (*Annales de Chimie et de Physique*, sér. 3, vol. lvii.). Nothing can be more beautiful than the effect presented by a mass of rough rubies when the molecular discharge plays on them in a high vacuum. They glow as if they were red hot, and the illuminating effect is almost equal to that of the diamond under similar circumstances.

By the kindness of M. Ch. Feil, who has placed large masses of his artificial ruby crystals at my service, I have been enabled to compare the behavior of the artificially formed crystals with that of the natural ruby. In the vacuum there is no difference whatever; the color of the phosphorescence emitted by M. Feil's crystals is of just as intense a color, and quite as pure in character, as that given by the natural stone. This affords another proof, if one were needed, that Messrs. Fremy and Feil have actually succeeded in the artificial formation of the veritable ruby, and have not simply obtained crystals which imitate it in hardness and color.

The appearance of the alumina glow in the spectroscope is remarkable. There is a faint continuous spectrum ending in the red somewhere near the line B; then a black space, and next an intensely brilliant and sharp red line to which nearly the whole of the intensity of the colored glow is due. The wave length of this red line, which appears characteristic of this form of alumina, is 689·5 mmm., as near as I can measure in my spectroscope; the maximum probable error being about $\pm 0 \cdot 3$.

This line coincides with the one described by E. Becquerel as being the most brilliant of the lines in the spectrum of the light of alumina, in its various forms, when glowing in the phosphoroscope.

This coincidence affords a good proof of the identity of the phosphorescent light, whether the phosphorescence be produced by radiation, as in Becquerel's experiments, or by molecular impact in a high vacuum.

I have been favored by my friend Prof. Maskelyne with the following notes of results obtained on submitting to the molecular discharge various crystals which he lent me for the purpose of these experiments:

"Diamond crystals. A very small crystal, exhibiting large cube faces with the edges and angles truncated, was of a rich apricot color, the dodecahedral faces of a clear yellow, and the octahedral of another yellow tint. No polarization of the light was detected. Some were opaque; some gave a bluish hazy light.

"Emerald. A small hexagonal prism gave out a fine crimson red color. The light was polarized, apparently completely, in a plane perpendicular to the axis; this would correspond therefore to extraordinary rays which in emerald, as a negative crystal, represent the quicker rays vibrating presumably parallel to the optic axis of the crystal.

"Other emeralds behaved in the same way, though the illumination in two others experimented with appeared confined more particularly to one end—the end opposite to that at which the crystals presented some (in one instance fine) terminal faces.

"Beryls exhibited no corresponding phenomena.

"Sapphires gave out a bluish gray light, distinctly polarized in a plane perpendicular to the axis. In this case, again, the ray developed corresponds to the extraordinary or quicker ray.

"Ruby gives out a transcendently fine crimson color exhibiting no marked distinction in the plane of its polarization, though in one part of a stone the color was extinguished by a Nicol prism with its long diagonal parallel to the axis of the crystal. Here, therefore, also, the light was that of the extraordinary ray.

"It seemed desirable to determine the nature of the phenomena in the case of positive crystals, and accordingly crystals of quartz, phenakite, tinstone, and hyacinth (zircon), were placed in a tube and experimented on.

"The only crystals that gave definite results were tinstone and hyacinth. A small crystal of the former mineral glowed with a fine yellow light, which was extinguished almost entirely when the long diagonal of the Nicol was perpendicular to the axis of the crystal.

"Here, therefore, the plane of polarization of the emitted light was parallel to the axis of the crystal, and here it is again the quicker, though in this case (of an optically positive crystal) it is the ordinary ray which corresponds to the light evoked by the electric stream.

"So far, then, the experiments accord with the quicker vibrations being called into play, and therefore in a negative crystal the extraordinary and in a positive crystal the ordinary is the ray evoked.

"A crystal of hyacinth, however, introduced a new phenomenon. In this optically positive crystal the ordinary ray was of a pale pink hue, the extraordinary of a very beautiful lavender blue color. In another crystal, like the former from Expailly, the ordinary ray was of a pale blue, the extraordinary of a deep violet. A large crystal from Ceylon gave the ordinary ray of a yellow color, the extraordinary ray of a deep violet hue.

"Several other substances were experimented on, including some that are remarkable for optical properties, among which were tourmaline, andalusite, enstatite, minerals of the augite class, apatite, topaz, chrysoberyl, peridot, garnets of various kinds, and parisite. So far, however, these minerals have given no result, and it will be seen that the crystals which have thus far given out light in any remarkable degree are, besides diamond, uniaxial crystals (an anomaly not likely to be sustained by further experiment); and the only conclusion arrived at is, that the rays whose direction of vibration corresponds to the direction of maximum optical elasticity in the crystal are always originated where any light is given out. As yet, however, the induction on which so remarkable a principle is suggested cannot be considered sufficiently extended to justify that principle being accepted as other than probable."—WM. CROOKES.

HEARING BY THE AID OF TISSUE CONDUCTION —THE MOUTH TRUMPET AND THE AUDIPHONE.

DR. SAMUEL SEXTON has published a paper explaining the *modus operandi* of hearing through the tissues of the head with the mouth trumpet and the audiphone. One of these conditions he believes to be more or less change in the membrana tympani, especially its loss of proper tension from trophic changes, or from results of inflammatory action; thus impaired, the membrane fails to perform its vibratory function in a normal manner. Or, the excursions of the membrane may fail of transmission to the labyrinth through displacement of the articular surfaces of the ossicula, the normal tension of the conductive apparatus of the middle ear thus being no longer maintained. When the integrity of the membrana tympani and the chain of ossicles is thus impaired, sound waves received by the teeth, or other parts of the head, may be transmitted through the bones, muscles, and other tissues of which the parts are composed, to the auditory nerve. Practically, Dr. Sexton has found that tissue conduction permits of conversation with the deaf by means of a mouth trumpet—a short tube of rubber extending from the speaker into the patient's mouth—although in an experience of some years he has not been able to satisfy himself that it is of value for general use. He recommends it, however, as promising good results, if used in the instruction of some deaf mutes who hear their own voice, but require the aid of normal sounds in order to learn to speak. Voice is heard by means of the audiphone in the same way as through the mouth trumpet, but the transmission in this case being effected through an uninterrupted and direct osseous route from the teeth to the ears, it is heard much more loudly; by no means, however, in a natural tone.

Dr. Sexton found that one patient, cited as an example, could hear the distinct voice of one person a few feet only, and that, although he had practiced with the audiphone of Mr. Rhodes for several months, he could hear no better with it than when he used it first. One patient, a lady, found the use of the instrument made her quite nervous, attempts to hear conversation at all well being quite ineffectual. It was observed that this lady had suffered loosening of a tooth from the pressure (and vibrations?) of the audiphone when in use. The author's patients found the audiphone inconvenient to carry about and exceedingly liable to be broken. Dr. Sexton concludes, from observations made on a number of patients who have used the audiphone, that, as at present constructed, its range of usefulness is rather limited, but that those who experience autophony—hearing their own voice—can derive more or less benefit from it if properly constructed. The writer does not doubt that, when a knowledge of tissue conduction of the head is more general, better instruments will be devised.—*The American Journal of Otology.*

STORED-UP LIGHT.

MORE than two hundred and fifty years ago a shoemaker of Bologna made the curious observation that if barium sulphide, which he obtained by the reduction of the sulphate, was exposed to sunlight for a short time and then taken into a dark room it evolved a considerable amount of light. After the barium sulphide had ceased to shine in the dark, it could be recharged with light by a renewed exposure to the sun's rays, or even to diffused daylight. Subsequent investigations have shown that very many substances have the above-mentioned remarkable property of absorbing light, and giving it out in a modified condition after the exciting cause has ceased. This phenomenon of light storing is known to physicists as phosphorescence; and the number of substances possessing it in a low degree is very large.

Many years after the discovery made by the Bolognian shoemaker, Canton found that an extremely powerful light magnet or phosphorus, as he termed it, might be obtained by the calcination of oyster shells with sulphur. The impure calcium sulphide thus obtained was found to emit so much light after isolation, or exposure to the sun's rays, that the light evolved from a small lump of it enabled one to see the time by a watch; and the luminosity of the isolated calcium sulphide often lasted as long as ten or twelve hours.

Daguerre was very successful in the preparation of Canton's phosphorus, and published details of manipulation which rendered the production of an exceedingly phosphorescent product a matter of ease and tolerable certainty. He also studied the photographic properties of the phosphorescent light, and found that it acted energetically on the sensitive Daguerreotype plate, just as is the case with ordinary solar light.

Experiments of an analogous nature were undertaken by Niépce de St. Victor, but although his results are of the greatest interest from a scientific and theoretical point of view, they do not appear to have led to any practical applications of phosphorescent light in connection with the photographic art. The experiments of more recent investigators prove that phosphorescence is generally excited by the violet and ultra violet rays, while the emitted light is always, or almost always, of a lower degree of refrangibility, and consequently of a more feeble actinic power. As regards the color of the emitted light, various tints of blue, green, orange, and yellow prevail, the same body often giving different tints of light in accordance with slight variations in the details of its preparation.

It is a remarkable fact that the evolution of light by phosphorescent bodies may be very rapidly brought to a termination by their exposure to the least refrangible rays of the spectrum, such as the red rays; and some remarkable results, founded on this circumstance, have recently been obtained by Lieutenant Darwin and by Mr. Warnerke; but as the experiments of these investigators have been recently described in the *Photographic News*, it is unnecessary to enter into details at present; more especially as our object is to point out that the absorption of light by many substances having only feeble phosphorescent properties, and the subsequent evolution of this light, may lead to fogging in the case of the extraordinarily sensitive gelatino-bromide plates which are so extensively employed at the present time. Many of the most successful workers with the gelatine emulsion process fully recognize the fact that it is very undesirable to admit a full flood of white light into the dark room immediately before darkening this apartment for the manipulation of sensitive plates, and we have heard of numerous instances in which plates have fogged after having been placed in proximity with white or light-colored objects recently exposed to the action of a powerful light.

It is interesting to note that most phosphorescent bodies are light-colored, so that little mischief need be apprehended from the approximation of dark-colored bodies to sensitive surfaces, even though the dark-colored bodies may have been quite recently exposed to the action of direct sunshine.

In order to obtain some definite ideas as to the extent of the danger above referred to, we made a few experiments with some feebly phosphorescent bodies more or less likely to be met with in the dark room, or to be brought into immediate proximity with sensitive films. Among these may be mentioned the diamond, chalk, lime, plaster of Paris, chloride of calcium, tartaric acid, sugar, silk, and paper.

Two glazier's diamonds were exposed for a few minutes to sunshine, and were then placed, crystal downward, on the face of a gelatino-bromide plate. They were allowed to remain for ten minutes, red light being excluded during this time. On developing the plate it was found that one diamond had made an impression on the film, while the other one had produced no apparent effect. The experiment was repeated with a piece of thin glass between the crystals and the film, and a similar result was obtained. In this case the phosphorescent diamond had a slight yellow tint, while the non-phosphorescent one was colorless. The phosphorescent diamond was again exposed to sunlight, and shut up in a dark box for one minute; being now placed on a gelatine plate, and allowed to remain for ten minutes, it was found that an impression could be developed by the application of an energetic developer. It was again similarly exposed to sunlight, but, instead of being placed in a dark box for one minute, it was exposed to the radiations of a red lamp for a similar period. After this it was placed in contact with a sensitive film as before, but in this instance no trace of an impression was revealed on applying the developer. In this case, then, it is evident that the red light extinguished the phosphorescence of the diamond during the minute of time during which it was allowed to act.

In order to test the phosphorescent power of chalk, lime, plaster of Paris, chloride of calcium, and sugar, a kind of rough negative was prepared by gumming two strips of black paper, in the form of a cross, on a glass plate. This being placed, paper side upward, on a gelatine plate, the insolated substance was piled upon the paper cross. In each case some slight effect was produced, provided that the phosphorescent material had been sufficiently moved and stirred about during exposure to sunlight to saturate every part of it with light. In the case of one sample of plaster of Paris the phosphorescence was very energetic, a distinct impression being produced by allowing it to remain one second on the paper cross; while in the case of the chloride of calcium and sugar only an extremely feeble image was produced, even by an exposure of ten minutes.

We also tried the effect of covering the paper cross with each of the above-mentioned substances, and then allowing red light, from an ordinary non-actinic lantern, to shine on the under surface of the plate, and it proved that five minutes' exposure to this light was sufficient to extinguish the phosphorescence of either one of them.

Now, as regards white paper and silk, the results were very various, but no sample of either of these displayed so much phosphorescence as the specimen of plaster of Paris which we mentioned just now. No phosphorescence was noted unless the paper or silk was carefully dried, and even then it rapidly disappeared even in darkness, and almost instantly on exposure to red light. In order to test the matter thoroughly, a box was lined with a quality of white paper which had been found to possess some degree of phosphorescence; and the inside of this box, after having been carefully dried, was exposed to sunshine. The box being now rapidly removed into a perfectly dark room, a slide containing a plate was immediately introduced; and the shutter being half drawn the box was closed, and allowed to remain for five minutes. At the end of this time the developer was applied, and it was found that the half of the plate which had been exposed to the radiations of the paper was distinctly fogged. After the removal of the first plate, another slide containing a plate was introduced into the paper-lined box; but no trace of the action of light became visible on applying the developer.

A friend of ours having had his cellar newly whitewashed, we obtained his permission to make the following experiments therein. In the first place, the cellar was carefully rendered perfectly light-tight, so that a gelatine plate might remain in it for hours without suffering any injury. We then burned about a quarter of an ounce of magnesium wire therein, taking care to well expose all the walls and corners thoroughly to the action of the light. It was now found that a plate was immediately fogged by exposure in the cellar, and it required a long exposure to the radiations of a ruby lamp to thoroughly restore the safe condition as regards gelatine plates.

In the instances above cited, we were working with substances of such feeble phosphorescent power that the emitted light was too weak to affect an eye of average sensibility; but it is highly probable that such powerfully phosphorescent bodies as Canton's phosphorus or Balmain's luminous paint will become of increasing interest to the photographer in other ways.—*Photographic News.*

THE TANNING PROCESS.

By DR. CARL BOTTINGER.

THE chief results of the author's important investigations into the theory and practice of tanning are as follows:

Tannin is an excellent solvent for phlobaphen (which is identical with oak red). Phlobaphen and tannin play the chief part in bark tanning. It may be considered as very probable that phlobaphen is the true tanning agent, and that the tannin merely determines its combination with the hides. The author proves the joint presence of phlobaphen and tannin in leather, *i. e.*, their joint action in the process of tanning, by washing fine shavings of leather with water, and then extracting them with water containing four per cent. of carbonate of soda. He detected both substances in the brown extracts. Even if leather is extracted three or four times with solution of carbonate of soda, it still retains a reddish brown color, though soda now extracts little more from it. If it is next repeatedly treated with caustic soda lye it gives off large quantities of a mixture of phlobaphen with a little tannin.

Ten successive extractions are necessary to render the leather translucent.—*Chemiker Zeitung and Annalen der Chemie.*

[Hence it appears that the determination of the quantity of tannin in any bark, wood, or other astringent vegetable matter, does not suffice to show its comparative value for tanning purposes.—ED. *Chemical Review.*]

THE VALUE OF CHEMICAL INVESTIGATIONS OF FOOD.

PROFESSOR DR. H. . LECK, the President of the Royal Chemical Central Station at Dresden, Saxony, has contributed to the *Chemiker Zeitung* a leading article which is deserving of attention, and the chief contents of which are as follows:

We frequently read the written opinion of druggists, physicians, and chemists, in which these gentlemen proclaim, on account of having made a scientific investigation, as they say, that an adulteration of food has taken place; and whenever we read such an opinion we should ask ourselves the question, Has any expert the right to make such an assertion because he has made a scientific inquiry?

The chemist may state that the specimen of the food which he has investigated has not the quality it should have according to the price, and that it is deteriorated; he may also maintain that this deterioration is unwholesome and obnoxious; but he will never be entitled to declare that his scientific experiments are a proof of the "*dolus ex p oposito*," *i. e.*, of an intentional fraud. This latter is a subject for judicial inquiry, and has to be decided in the forum rather than in the laboratory. When a so-called expert makes the declaration that a certain kind of wine or beer has been adulterated or is of an inferior quality, the importer or manufacturer of this liquid would be justified in commencing a law suit; for though this expert may have a right to say that the specimen which was sent to him had not the desired quality, he is not entitled to give his opinion on the whole quantity.

The influence of such a carelessly given opinion may injure very greatly the interest of the manufacturer, and the reputation of the chemist may be likewise hurt should he announce, without any special reference to the examined specimen, that the food from which it was taken is of a good quality, if it afterwards proves that the quantity sold to the public is of an inferior character to the specimen he received.

But even if the above-mentioned mistakes are avoided, the results of a so-called chemical investigation of food are of doubtful value, as the following will show:

Our literature contains a good many books and pamphlets treating on the scientific investigation of food, and in which are recommended certain methods for the quick detection of obnoxious and unwholesome elements. Valuable as these recommendations would be, if they always secured the desired result, they are dangerous in the hands of the half-educated chemist if they do not possess this quality. And what method could be considered infallible in every case?

All methods proposed for the chemical examination of substances have only a relative worth, and have to be modified in every single case. Whoever, therefore, tries to accomplish an analysis, by following general prescriptions, not only cannot be called a scientific expert, but also is apt to be misled by his experiments and to obtain perfectly worthless results.

A further proof for the truth of this assertion is the following case:

The teacher of a German college, who also gave lessons in chemistry, examined, at the instigation of a certain society, the beer manufactured in this town, and proclaimed afterward in a public lecture that the examined beer was adulterated with picric acid. The proprietors of the brewery upon whom this reproach was cast, and who, as a natural consequence, lost most of their customers, complained at the Chemical Central Station at Dresden, and the beer was carefully examined. First, for the purpose of obtaining a correct view of the value of the popular methods for examining beer, some beer in a perfectly pure state and of the same color was examined, and also some to which 10 milligrammes of picric acid per liter had been added. The first remarkable fact was, that after the picric acid had been added no striking decoloration took place. Then followed the well-known experiments of immersing a woolen thread into the acidulated liquid, the decoloration by means of animal coal, and the precipitation by acid of lead, and the results obtained were: (1) The woolen thread received a genuine yellow color in the pure beer as well as in that to which had been added the picric acid; (2) animal coal decolored both liquids alike; (3) after the precipitation by acid of lead a perfectly clear and colorless liquid was obtained in both cases. Thus it was seen that, by those methods, under no circumstances could the presence of picric acid be proved, and that an expert who, upon the strength of these experiments, as the teacher above-mentioned had evidently done, proclaims an adulteration, is deserving of no attention whatever. During the further progress of the investigation, when the extract of the beer had been dissolved in alcohol, the solution evaporated, and the residue treated with ether, the small quantity of 10 milligrammes per 1 liter of beer was determined with almost quantitative accuracy in that specimen to which it had been added, while in the beer taken from the accused brewery no trace was found. The reproach was, therefore, pronounced unjust.

In a recent work on the chemical analysis of food we read the following sentence: "If we want only to know whether the bitter taste of a certain beer is produced by hops, or if any other substance has been used, then the examination is *very easy*." And another sentence says: "Picric acid, also, *which of all substances is mostly used for givi g to the beer its bitter tas'e*, can easily be detected."

These two sentences are another proof for the assertion we have made above, viz., that the opinion of experts, who take their information from books only, is of scarcely any value.

The author of these two sentences, who proclaims that his book is a perfect guide for those who have no knowledge in analytical chemistry, takes a great responsibility in making the assertion that picric acid is a substance commonly used to replace the hops. He seems not to be acquainted with the fact that hops is employed by the brewers not so much on account of its bitterness, but on account of its valuable clearing property and its aroma, which cannot be easily replaced by any other substance.

The bitterness of the hops is of no benefit whatever for the brewing, and our brewers would be only too glad if this plant could be deprived of it without destroying its other qualities. The tale that foreign substances are added to the beer for the producing of a bitter taste, seems, therefore, to belong to the realm of mythology, and if such substances are added, they certainly serve for another purpose The invalidity of the assertion, which so often has been made, that "colchicum" is used for the adulteration of beer, has been likewise proved, since Dr. Griesmaier has shown that lupulin produces almost the same chemical reactions as colchicum, and that the one has very likely been often mistaken for the other. Thus more and more proofs of the inaccuracy of food-examinations have come to light, and it is to be hoped that the public will commence to pay less attention to the opinion of our pseudo-chemists, or that the difficult task of a scientific analysis would only be intrusted to such men who, by their ability and long experience, are enabled to give an opinion which has the value of being correct.

A BROMATED DERIVATIVE OF NICOTINE.

By A. CAHOURS and ETARD.

THE authors have not succeeded in reproducing C. Huber's compound, $C_{20}H_{12}N_2Br_6$. They have, however, obtained another bromine derivative of nicotine by dissolving 1 part of nicotine in 50 of water, and adding, with agitation, 4 atoms bromine per mol. of nicotine. An abundant yellow flocculent precipitate was formed. On heating the liquid to 65° to 70° by means of a current of steam, filtering, and cooling the precipitate, long fine red crystals were deposited. If these crystals are dissolved in hydrobromic acid, the solution, on cooling, deposits a crystalline product less red than the former, probably a hydrobromate of the primitive derivative. This compound has the composition $C_{20}H_{14}N_2Br_4$. Huber's compound is probably a hydrobromate of this derivative formed by addition.

A NEW ALUMINUM SULPHATE (SESQUIBASIC).

By P. MARGUERITE.

ON examining aluminum sulphate resulting from the decomposition of ammonia alum by heat, a new sulphate has been obtained, answering to the formula $Al_2O_3,2SO_3,12HO$. If this formula is calculated for 3 equivs. sulphuric acid it would be $\frac{3}{2}Al_2O_3,3SO_3,18HO$, and if compared with the monobasic, bibasic, and tribasic sulphates, it would be sesquibasic salt. It occurs in well-defined crystals, rhombohedra, sometimes simple and sometimes terminating in four-sided pyramids. It dissolves readily in hot and cold water. It is almost neutral to litmus-paper, and is without action upon ultramarine. It contains 21 per cent. of alumina—that is, twice as much as alum and one-half more than the ordinary sulphate. The new compound is the tenth simple aluminum sulphate which has been obtained and analyzed.

ON THE CRITICAL POINT OF MIXED VAPORS.*

THE following record of experiments regarding the behavior of carbonic acid in presence of different vapors above the temperature of the critical points of the pure gas were undertaken to see if any optical discontinuity could be observed in such mixtures above this temperature. The object was intentionally a qualitative investigation, and thus many of the pressure observations have been taken from the metallic manometer.

THE LIQUEFACTION OF CARBONIC ACID IN PRESENCE OF OTHER BODIES.

1. *Carbonic Acid and Bisulphide of Carbon.*—Carbonic acid liquefied in presence of bisulphide of carbon, at a pressure of 49 atmospheres and a temperature of 19° C., floated on the convex surface of the bisulphide, the line of separation being sharp and well defined, and remaining so.

At 35° C. liquid condensed on the surface of the bisulphide, in the same way, at a pressure of 78 atmospheres; at 40° C. it still appeared, at 85 atmospheres; at 55° C. there seemed to be a distinct appearance of two liquids, and at 58° C. there was still the same apparent separation under a pressure of 110 atmospheres. Observed at 47° C., and a pressure of 80 atmospheres, there was a distinct layer of a separate fluid on the surface of the bisulphide; the bisulphide surface, however, was not so well defined.

By keeping the temperature at 47° C., on increasing the pressure to 110 atmospheres, the upper surface of the liquid floating on the bisulphide almost entirely disappeared. By reducing the pressure again to 80 atmospheres the surface of demarkation disappeared; but in reducing the pressure another 5 atmospheres, the line of demarkation again appeared very sharply, and remained. A quick withdrawal to 53 atmospheres, and again gradually increasing the pressure to 85 atmospheres, did not make the liquid remain, but on reducing it again slowly to 80 atmospheres the definition became perfectly sharp.

2. *Carbonic Acid and Chloroform.*—Carbonic acid in presence of chloroform at 18° C. liquefied at 25 atmospheres, forming a distinct layer on the surface of the chloroform. On further compression the manometer rose rapidly to 50 atmospheres, at which pressure the two liquids mixed completely together, after being left for a few minutes. When the pressure was rapidly withdrawn distinct layers of what appeared to be carbonic acid were always formed, which, however, became rapidly dissolved in the chloroform on standing a few seconds.

At 38° C. liquid began to appear at a pressure of 35 atmospheres, and on increasing the pressure to 55 atmospheres it behaved in exactly the same way as at the lower temperatures, except that the layer was, if anything, more distinct and mixed more rapidly with the chloroform on standing.

At 55° C. a layer of liquid was still formed at a pressure of 50 atmospheres; at 67° C. it behaved in the same way, except that there was a smaller quantity of liquid formed, and the pressure rose to 85 atmospheres.

In every case it rapidly mixed with the chloroform when left for a few seconds.

3. *Carbonic Acid and Benzol.*—At 18° C. the carbonic acid commenced to liquefy at a pressure of 25 atmospheres, and at the moment of liquefaction the surface of the benzol became violently agitated, the carbonic acid falling through the benzol in an oily stream, and becoming completely mixed with it.

When by further condensation more liquid was formed the agitation almost entirely ceased, the liquid carbonic acid forming a distinct layer on the saturated benzol. On leaving this for about five minutes the line of demarkation disappeared, and the two liquids formed a perfectly homogeneous fluid.

On again increasing the pressure so as to get a layer of carbonic acid, and then releasing the pressure gradually, the liquid carbonic acid on the surface first fell in oily streams through the saturated benzol; but when all this had disappeared the carbonic acid then commenced to boil from the bottom of the benzol, and continued to do so until it was again entirely vaporized.

At 35° C. liquid commenced to appear at 35 atmospheres, forming a distinct layer on the surface of the benzol, which was not in the least agitated. On further compression the liquid layer increased in volume, but no oily streams were seen to fall through the benzol; and on leaving it for about ten minutes the layer of liquid was almost just as distinct, showing that it was not nearly so soluble in the benzol at this temperature.

On the pressure being now reduced the liquid quietly evaporated away from the surface; but when all this had disappeared carbonic acid commenced to boil out of the benzol, showing that it had dissolved a considerable amount.

At 52° C. the liquid appeared at 60 atmospheres, forming a layer which mixed with the benzol on standing; and at 70° C. and 85 atmospheres a distinct layer was also formed, which, however, rapidly mixed with the benzol.

4. *Carbonic Acid and Ether.*—A tube was filled with carbonic acid, and a little ether introduced. At 20° C., and at a pressure of 20 atmospheres, the carbonic acid liquefied and fell through the ether, mixing with it in all proportions.

At 42° C. liquid was condensed on the surface of the ether at a pressure of 55 atmospheres, forming a distinct layer; the upper surface of the ether was, however, kept in continual oscillation, from the apparent solution of the carbonic acid in it. No currents due to the falling of the carbonic acid through the ether were visible. At 68° C., and a pressure of 110 atmospheres, a perfectly separate layer of fluid was found on the surface of the ether, and no currents were descending through the ether.

5. *Carbonic Acid and Nitrous Oxide.*—When a tube was filled with equal volumes of carbonic acid and nitrous oxide, and the gases were liquefied, they mixed together in all proportions, no difference at all being perceptible; but when the pressure was suddenly withdrawn the one gas boiled before the other, and for a few seconds a distinct line of separation was seen.

LIQUEFACTION OF CARBONIC ACID WITH TRICHLORIDE OF PHOSPHORUS.

At 16·20° C., and 42·95 atmospheres pressure, the carbonic acid commenced to condense on the sides before the trichloride of phosphorus came in sight, and when the latter was visible a slight indistinct layer of CO_2 was seen on the surface, only distinguishable by the different refractive indices of the two liquids, there being no sharp line of demarkation. On standing a few minutes the liquids became quite homogeneous. On increasing the pressure more carbonic acid was condensed, forming a more or less distinct layer on the surface of the trichloride of phosphorus. This, however, rapidly disappeared on standing. On releasing the pressure the carbonic acid boiled first on the surface, but afterward through the liquid, the trichloride of phosphorus at the same time falling in heavy striæ to the bottom.

At 23° C. the carbonic acid appeared to liquefy at 46·91 atmospheres, exactly the same appearances taking place as at 16° C.

At 30° C. the carbonic acid liquefied at 49·94 atmospheres, forming a rather more distinct layer, and not mixing so readily. On increasing the pressure to 90 atmospheres the surface of the carbonic acid disappeared, it being near its critical point, the top part of the tube being filled with a homogeneous mass. The trichloride of phosphorus could also not be distinguished on the surface of the mercury, its upper surface being entirely mixed up with the carbonic acid, the whole space above the mercury forming one homogeneous mass.

On releasing the pressure a cloud first appeared, and then the surface of the carbonic acid became visible; it boiled away first from the surface, and afterward through the trichloride of phosphorus.

At 33° C.	liquid carb.	acid	appeared at	50·84	atmos.
" 40	"	"	"	56·88	"
" 50	"	"	"	66·53	"

At all the temperatures above 30° C. the appearances were the same, except that as the temperature increased the quantity of carbonic acid liquefied diminished, and it took a great pressure to make the surface of the trichloride of phosphorus disappear.

The following are pressures taken with a smaller quantity of carbonic acid and trichloride in the tube, and were read off when the surface of the trichloride was first agitated, thus showing that the carbonic acid had commenced to condense:

At 10·5° C	22·70	atmospheres.
" 16·5 "	24·70	"
" 22·8 "	32·18	"
" 30 "	33·88	"
" 40 "	36·36	"
" 50 "	49·67	"
" 70 "	76·61	"

LIQUEFACTION OF CARBONIC ACID WITH TETRACHLORIDE OF CARBON.

The quantity of tetrachloride of carbon was a little less than the volume of the carbonic acid when liquefied.

12·8° C. the surface of the liquid appeared agitated as soon as it appeared in sight, and on increasing the pressure, a distinct layer of carbonic acid was formed on the surface of the tetrachloride; on increasing the pressure a still more distinct layer was formed, which, however, on standing, rapidly commenced to dissolve in the tetrachloride, and in about ten minutes it was perfectly homogeneous.

At 21·4° C. the surface of the tetrachloride appeared agitated when it came in sight, a layer of liquid being formed on increasing the pressure, as at 12° C.

At 30° C. liquid was also formed, which, however, rapidly diffused into the tetrachloride of carbon.

At 40° C. the liquid also appeared agitated, and on increasing the pressure rapidly a small quantity of fluid was condensed, which, however, rapidly disappeared in the tetrachloride.

At 52° C. the liquid again became agitated, and on increasing the pressure a distinct layer of liquid was formed.

The same took place at 58° C.

LIQUEFACTION OF CARBONIC ACID AND CHLORIDE OF METHYL.

When chloride of methyl was compressed in a tube by itself it became liquid before the pressure could be registered, and must have been below 10 atmospheres.

When compressed with about twice its volume of carbonic acid, at 13·5° C.—the chloride of methyl, of course, liquefied first—and about 27·67 atmospheres, its surface became agitated, showing that the carbonic acid had commenced to liquefy; but the exact point was difficult to ascertain, as it dissolved so very rapidly in the chloride of methyl.

At 20·05° C. this point appeared to be at 28·57 atmospheres.

At 30° C. some liquid was also condensed, but the pressure

* A paper read before the Royal Society, June 17, 1880, by James Dewar, M.A., F.R.S., Jacksonian Professor of Natural Experimental Philosophy in the University of Cambridge.

at commencement of liquefaction could not be taken, as it mixed so rapidly with the chloride of methyl.

That more liquid was in reality condensed was seen by the lengthening of the liquid column, and by its boiling out of the chloride of methyl when the pressure was reduced.

At 40° C. exactly the same took place.

CARBONIC ACID AND ACETYLENE.

About equal volumes of these gases were compressed together; they liquefied and mixed completely at all the temperatures given below, and no appearance of two different gases being liquefied was visible, except that the liquid was strongly agitated during condensation. The pressure at the point of liquefaction was, as in the former cases, lower than either of the gases liquefied by themselves. Thus:

At 13·5° C. the pressure was	25·23	atmospheres.
" 21 " " "	26·8	"
" 26·8 " " "	34·1	"
" 31·9 " " "	40·26	"
" 39 " " "	55·3	"
" 41 " " "	75·32	"

The critical point was, on the other hand, heightened as usual, being 41° C.; that of carbonic acid being 31° C., and of acetylene 37° C.

CARBONIC ACID AND HYDROCHLORIC ACID GASES.

A mixture of equal volumes of these gases was filled into a tube, and the liquefied gases mixed completely together at all temperatures below the critical point, which was 36° C., forming a perfectly homogeneous fluid; in fact, it was impossible to tell that two different gases were present, as even at the point of liquefaction no difference was discernible.

The following are the pressures at which the mixture liquefied:

At 0° C.	36	atmospheres.
" 5 "	39	"
" 8 "	43·8	"
" 10·1 "	48·2	"
" 18·5 "	59	"
" 34 "	83	"
" 35·5 "	90	"

CARBONIC ACID AND BROMINE.

A tube was filled with a mixture of carbonic acid and bromine vapor, by passing dry carbonic acid through a tube containing dry bromine before entering the liquefying tube. A little strong sulphuric acid was also introduced to protect the mercury. On compressing this mixture at 11·5° C. the sulphuric acid appeared in sight with a layer of liquid at 50 atmospheres, the liquid having a decidedly red color.

On increasing the pressure the liquid became more highly colored, while a little pure bromine liquid fell through the carbonic acid liquid, remaining a short time on the surface of the sulphuric acid, through which a globule also sank.

As this tube was spoiled through the amount of bromine which fell through the sulphuric acid, another was put up in the same way, and heated at once to about 40° C., before compressing the mixture.

On the sulphuric coming in sight a small layer of bromine was seen on the surface, which was surmounted by a layer of darkish red liquid, about half an inch long. The pressure was about 60 atmospheres.

On increasing the pressure to 90 atmospheres the upper liquid increased a good deal in quantity, and then disappeared entirely, but immediately reappeared on reducing the pressure a few atmospheres, and remained permanently.

CARBONIC ACID AND CAMPHOR.

Some small pieces of camphor were placed in the capillary part of an ordinary Cailletet tube, near the end, and fused so as to adhere to the sides. The tube was then filled with carbonic acid gas.

On compressing this mixture in the pump at 12° C., the camphor was seen to melt and run down the sides of the tube before the mercury appeared in sight. (In this experiment it was not observed whether liquid carbonic acid had commenced to form in the tube, and thus dissolve the camphor, or whether the latter was dissolved in the gas.) On continuing the pressure, so as to almost fill the tube with liquid, two distinct layers of liquid were seen, the lower one being slightly cloudy, containing the dissolved camphor, the upper liquid being perfectly clear. On compressing at different temperatures up to 35° C. the lower cloudy liquid was always present the upper layer diminishing gradually in quantity as the temperature rose; but at 40° C. there was still a slight layer on increasing the pressure to about 125 atmospheres.

On withdrawing the pressure very suddenly, when the tube was full of liquid at 30°, the sides of the tube became coated with crystallized camphor, which rapidly dissolved again on increasing the pressure. After doing this several times a very small quantity of camphor was seen to crystallize out, and in taking down the tube the most of it was found to have crystallized out in the top part of the reservoir near the joining with the capillary part, thus allowing the mercury to get past it on again increasing the pressure.

CARBONIC ACID AND CAMPHOR (SECOND TUBE).

Another tube was filled in the same way as the last (a rather larger quantity of camphor being placed in the capillary part), with this exception, that the carbonic acid, after being dried, was passed through a tube containing fragments of solid camphor, which were gently heated, so as to fill the tube with carbonic acid gas saturated with the vapor of camphor.

When this tube was compressed in the pump at a temperature of 15° C., and when the pressure reached 27·7 atmospheres, the camphor was seen to gradually melt and run down the sides of the tubes before the mercury appeared in sight.

On increasing the pressure to 37 atmospheres the mercury appeared in sight, with about three-quarters of an inch of a turbid liquid on the surface. On still further increasing the pressure two distinct layers of fluid were formed, which, however, became quite homogeneous after a short time. On mixing them up by a rapid decrease and increase of pressure, the two fluids soon mix. At 28° C. two layers of liquid were distinctly visible at 65 atmospheres, the lower layer being visible as soon as the mercury appeared in sight.

At 35° C. carbonic acid was condensed on the surface of the lower liquid at 80 atmospheres, but when the pressure was increased to 100 atmospheres the surface of the carbonic acid became undefined.

At 45° C. carbonic acid is seen to condense on the sides of the tube at a pressure of 100 atmospheres, running down and forming a slight layer on the surface of the camphor liquor, which, however, disappears on still further increasing the pressure.

When the temperature was 42·5°, and the pressure was suddenly reduced, the inside of the tube became covered with crystals of camphor. On now increasing the pressure very carefully the camphor was seen to melt or liquefy and run down the sides of the tube at a pressure of 37·6 atmospheres; and this pressure scarcely increased at all until all the camphor was thus liquefied.

A diminution of the pressure by two or three atmospheres was sufficient to bring out the crystals of camphor.

At 60° C. the lower layer of liquid still remained, and on increasing the pressure to 100 atmospheres there was an appearance of liquefaction of carbonic acid on the surface.

CARBONIC ACID, AIR, AND CAMPHOR (THIRD TUBE).

A quantity of camphor was placed in the capillary part of a tube as before, which was afterwards filled with a mixture of 4 volumes of carbonic acid, saturated with camphor vapor, and 1 volume of air.

The tube was surrounded with water at 25° C., so as to be far above the critical point of the carbonic acid and air mixture, and on now increasing the pressure the camphor liquefied and ran down the sides of the tube as before. At 50° C. a quantity of liquid, about one half inch long, appeared on the surface of the mercury when it came in sight, the pressure being now 65 atmospheres.

On leaving the pressure the same, the mercury being just in sight, and increasing the temperature gradually to 60° C., the inside of the tube above the liquid became covered with camphor crystals, which on increasing the pressure another 5 atmospheres (viz., to 70 atmospheres) again dissolves.

At 65° C., the pressure standing at 70 atmospheres and the mercury and liquid being in sight, on reducing the pressure to 65 atmospheres the camphor crystals separated out, being again suddenly dissolved on again increasing the pressure to 73 atmospheres. On now rapidly letting down the temperature to 15° C. a white mass of camphor separated out from the liquid, which again dissolved on a slight increase of pressure, although it could not be again separated out by diminishing it. These actions may be due to supersaturation and the effect of pressure in aiding solubility when contraction takes place during solution.

These experiments show that carbonic acid at high pressures, in presence of various substances, acts as if it produced a series of unstable chemical compounds, which are decomposed and re-composed according to the conditions of temperature and pressure in the medium.

MANUFACTURE OF CITRIC ACID.*

By J. CARTER BELL, F.C.S.

THE following paper is written, not from theoretical but practical knowledge. For some time I have been engaged with experiments upon citric acid, with the view of lessening the great loss which occurs during the process of manufacture - a manufacture which I have been obliged to abandon, owing to the great care which is required in the work, and not having had the time which is requisite for such a delicate chemical process. It is not often that authors record their failures in print; I do so now as a warning to those who may feel inclined to embark in similar enterprises. After finding my workmen had destroyed and wasted many gallons of liquor, I thought it was time to hand over the works to one who could give his sole attention to them.

Buying the Lemon Juice.—A novice in the trade may lose a large sum at starting by not knowing how to buy the juice, for it seems the custom is to buy the juice by the old English gallon, and three pipes which were sent to the works were described in the invoice as containing 130 gallons in each pipe, whereas, when they were measured the quantity was found to be only 108 imperial gallons. Some Liverpool merchants very much wished to sell me 10 pipes of juice, each gallon to contain 64 ounces of crystallized citric acid. I agreed to take them if each pipe contained 130 English imperial gallons, and each gallon to contain 64 ounces of crystallized citric acid, English weight; they declined to execute the order, saying that the juice was sold according to the old English measure. The juice, which is generally concentrated before it arrives in this country, contains about four pounds of citric acid in each gallon; I have had it as high as six pounds to the gallon. The appearance of the juice is like thin black treacle, and on dilution with water a considerable quantity of organic matter is precipitated.

The following description is for working up two pipes of juice at the same time, for the labor is nearly the same as for one:

A cistern must be provided capable of holding twelve hundred gallons; into this two pipes of juice are put, diluted with eight pipes of water, the colder the water is for this purpose the better, because the flocculent matter, which separates on dilution, is partially redissolved on warming. To allow this to settle, the solution must be allowed to stand for a day or two. Weak liquor should never be kept too long, as it has a tendency to decompose. When the solution is clear, it can be drawn off and allowed to flow through a sugar-bag or filter. These bags are made in Manchester, without seam, specially for the sugar makers; they are about six feet long and one in diameter. When the liquor has all passed through the bag, the solution may now be boiled up by means of steam blown into it at about 10 pounds pressure; when the liquor boils, fine whitening, which must be practically free from alumina, iron, and magnesia, is thrown in by small quantities at a time. Great care must be exercised that no lumps are introduced into the liquor, for they will fall to the bottom and thus a large excess of chalk may be used; it is advisable to mix the chalk with water, to the consistence of cream, or rather thicker, and pour the mixture in very gradually, taking great care that the contents of the vat do not overflow. The lime carbonate must be most accurately weighed, as the quantity of sulphuric acid necessary to decompose the citrate of lime can then be calculated. My practice was to estimate the amount of citric acid in the juice, and then, after analyzing the chalk, calculate the amount which was required; when all the chalk has been added, the mixture must be boiled for half an hour, agitating the whole time. The citrate of lime is now allowed to settle; the supernatant liquor, if found free from citric acid, is run off; and for this purpose two holes may be made in the vat, one just above the citrate of lime deposit, and another six inches above. Notice must be taken where the citrate of lime rises to, as this will be the same in all cases if the same quantity and strength of juice be used; these holes may have gun-metal taps in them, or tubes with India-rubber and a clip. If taps are not convenient, have a large siphon; anything so that it will run the water off quickly.

The object to be gained is to wash the citrate of lime as speedily as possible. Near this vat must be placed a citrate of lime washer, which consists of a frame made of wood, about six to eight inches deep, having a wooden bottom perforated with holes a quarter of an inch in diameter, and it is rather important that there should be no corners to this frame, therefore they must be curved off; if there are corners the citrate of lime is apt to lodge in them and decompose.

The citrate of lime washer must be made large enough to hold the one charge of citrate of lime; the size necessary can easily be calculated by noticing the depth of citrate of lime in the washing vat. The depth of the citrate of lime upon this washer should not exceed four inches. A piece of unbleached calico, rather larger than the bed of the washer, must now be spread smoothly over the bottom, and just allowed to overhang the sides. The supernatant liquor of the citrate of lime is now run upon the calico filter, in order to arrest any particles of citrate of lime. About one hundred gallons of hot water is poured upon the citrate of lime, well agitated, then allowed to settle and run off as before, while hot, because the citrate of lime is more soluble in cold water than hot. Repeat this two or three times, then run the citrate of lime on to the washer with sufficient water to make it flow easily. When all the liquor has drained away, the surface of the citrate of lime must be beaten all over with a little wooden pallet to prevent any cracks forming. When this is done give the citrate of lime a final wash with cold water about an inch in depth. The time required for washing this citrate of lime may vary almost in every case, as it depends very much upon the state of the citrate of lime; if it has a crystalline appearance, the easier it will be to wash; thus the time may vary from one to three days. Three days is a very extreme case. In summer it will require more time than winter, and also decomposes sooner. The citrate of lime in draining is very liable to form cracks upon the surface, and when water is poured, it would easily run through, without properly washing the citrate of lime, therefore the surface must be broken up.

There is no doubt that the tediousness of this washing would be much shortened by using a filter press.

When the citrate of lime has been well washed it must be taken out of the drainer and put into about one hundred and fifty gallons of cold water; this water must be in a tub with an agitator. When all the citrate of lime has been added, then put in brown oil of vitriol about 140° Twaddle, one per cent. in excess of the equivalent of carbonate of lime, but not more than one and a half per cent. Great care must be used in adding this acid; it must be weighed. When all the sulphuric acid has been added, agitate for an hour. The mixture will not require warming, as the heat generated by the addition of the sulphuric acid will be sufficient for the decomposition of the citrate of lime. When the agitation is finished, let the contents of the tub run on at once to the washer previously described.

The washing of the sulphate of lime requires great care. You must continue washing till the filtrates are no longer acid to the taste, or only slightly so. No certain rule can be laid down, as the number of washings may vary in each case. The last two or three washes may be used for the dilution of the crude juice. At each wash let the surface be covered with one inch of water, and before the new waters go on the sulphate of lime must be well drained each time, and between each wash the surface of the sulphate of lime must be well agitated, or cracks may be formed in the partially dry mass, which will allow the water to run through without percolating the whole of it. The cake of sulphate of lime should not be thicker than from four to five inches, and a similar filter may be used as in the washing of the citrate of lime. The free sulphuric acid in the juice will very soon rot the calico filters; therefore, perhaps, it would be more advisable to use a flannel for filtering. In washing the sulphate of lime it is better to use a small quantity of water each time, and a greater number of washes. The weak solution of citric acid is now run into a leaden evaporator. This may consist of a wooden box lined with lead. Into this must be put square tiles, and the best to use for this purpose are the tiles used in kilns for malt drying; they are perforated with very small holes. These must be put into the leaden tray, so as to present a perfectly flat surface. These are to be covered with water, and then a leaden evaporator will rest upon these tiles, being about one inch higher all round than the water-bath, as this will prevent the condensed water finding its way into the citric acid. On each side of the evaporator a steam pipe must be placed, capable of blowing steam into the water, and heating it to a certain temperature; also an overflow pipe, to carry away the condensed water. This evaporator should be nine inches deep, and it is better to make the sides square, and not sloping. The size of this evaporator must be in proportion to the quantity of liquor there is to evaporate down. When the weak acid is in the evaporator it must be evaporated down as quickly as possible at a temperature of 150° F., but not exceeding 160° F. When the acid is evaporated down to between 50° and 60° Twaddle, most of the sulphate of lime will have been precipitated. At this point it is better to siphon it off into another evaporator which stands at a lower level, and complete the evaporation in the second vessel. The evaporation must be carried on till a very slight film is observed upon the surface. The liquor must now be siphoned off into the crystallizing trays. These vessels should be about six feet long, two feet wide, and six inches deep; these must be lined with nine pound lead. These solutions should stand about two days, and be covered to prevent dust falling in. At the end of two days good brown crystals should be obtained. The mother liquors must be evaporated, and a distinct pellicle must be formed before the steam is turned off. This liquor can now be run into the crystallizers.

It is very important that the mother liquors should never be mixed with original liquors, as the crystals from the mother liquors will be of a darker color than from the original liquors.

Take the brown crystals—say four to five pounds of crystals to one gallon of water, dissolve, and boil with animal charcoal which has been deprived of its lime salts by hydrochloric acid (about one pound of charcoal to one hundred weight of crystals) in a leaden-lined tub with steam blowing in; stir with a paddle the whole time, and boil for about twenty minutes. This solution must be filtered into leaden perforated cones, the top being about eighteen inches square; calico is put into the leaden filters, and the filtrate is allowed to fall into a leaden vessel. This filtered solution must go into an evaporator kept solely for the purpose for white liquor, and evaporate at the same temperature as before. Now run off into the same crystallizing vessels, and cover them with wooden covers. These crystallizers should not be in a cold place, say about 60° F. Let these stand from two to four days. The mother liquor might go back into

* Read before the Society of Public Analysts, on April 14, 1880.

the white evaporator. Let the market crystals drain; dig them out with a copper spud, and take them to a butterman's table, break them up slightly, and water them with a watering can. Take them to a stove and dry at about 80° F., on shallow trays, one inch deep, and about two feet square.

A CONDENSED HISTORY OF DR. TANNER'S RECENT FAST.

By P. H. VANDER WEYDE, M.D.

THE reason that Dr. Tanner, a physician from Minneapolis, came to New York to submit to a forty days' fast under the supervision of our physicians, was a challenge of Dr. Hammond to a certain Miss Mollie Fancher, of Brooklyn, of whom it was asserted in the newspapers that she had lived fourteen years without food, and this for reason that she possessed wonderful clairvoyant powers, as her mind was independent from her body, and so powerful as to keep the vital functions going without food, by the mastery of the spiritual over the material body.

Such and similar statements were said to be made by the physician of that young lady, Dr. Spier, and it was accepted as true by all spiritualists and believers in the supernatural, while another class claimed that it was impossible, and that the claim of not having taken any food for so long a time was fraudulent, as nobody could be without food for a single month. Among those who loudest cried fraud was Dr. Wm. A. Hammond, late Surgeon General U. S. Army, who had published a little book on the frauds of "Fasting Girls," to which he added a challenge to Miss Fancher as appendix, in which he stated as follows: "I know something about fasting girls and their frauds. . . . If Miss Fancher will allow herself to be watched day and night for one month by relays of members of the N. Y. Neurological Society, I will give her $1,000 if at the end of that month she has not in the meantime taken food voluntarily, or as a forced measure to save her from dying of starvation, the danger of this last contingency to be judged by her family physician. If the offer is not taken up let us hear no more of Miss Fancher's mind reading or clairvoyance, or living for a dozen or more years without food."

Dr. Tanner saw the challenge in print, and knowing that Miss Fancher would not accept it, he wrote a letter to Dr. Hammond, offering himself as her substitute. It appears that Dr. Hammond's liberal offer was only intended for Miss Fancher (gossip says he did know beforehand that it would not be accepted). As Dr. Tanner's letter was not answered he wrote to Prof. Buchanan, requesting him to inform Dr. Hammond that he was ready to accept his challenge; this was done; no answer. Then Dr. Tanner published his offer in the *Pioneer Press* and sent Dr. Hammond a copy of the paper. Dr. Tanner did now not desire the $1,000, and even offered to pay his own expenses in full, and place himself under the supervision of the Neurological Society, Dr. Hammond, or such persons as they might select. No answer. As a last resort, an interviewer of one of the New York dailies (the New York *Times*) was sent to Dr. Hammond for an answer upon the published offer, and the reporter succeeded to get out of him the sentence: "You can publish me as saying that I will gladly accept Dr. Tanner's proposition." This was published in the New York *Times*, and Dr. Tanner seeing it, at once wrote to Dr. Hammond about the arrangements to be made, and at the same time he wrote a long letter to the New York *Times*, which was published in that paper Jan. 18, 1880, in which he criticised Dr. Hammond's published opinions, and mentioned several well authenticated cases of persons having lived four, five, six, and even seven weeks without food or water, so that Miss Fancher's case was not an isolated one. He mentioned the hibernating animals, and asked the question, if not man, under favorable circumstances, could do the same when partially suspending his functions?

Dr. Tanner closed this letter with the offer that "if the New York Neurological Society or any other medical society, or professor of any medical school interested in vital chemistry, desire to test the powers of human endurance under prolonged fasting, or witness the physiological, pathological, or psychological phenomena incident to such a fast, the proposal I made to Dr. Hammond is still open to their acceptance. . . . All I ask is to be provided with suitable apartments during my fast; all other expenses I will bear myself."

A few days after the publication of this letter a reporter called again on Dr. Hammond, who said, referring to Dr. Tanner, "The man is a fraud, but I will accept the proposition. He shall have a clean, well ventilated room; but out of that he must not go for thirty days, unless accompanied by persons above suspicion, so that he won't slip in some restaurant to get a good lunch. The more he walks, however, the more he will be apt not to succeed in the experiment, because in walking he will be using up his vital force. If he succeeds he will get the $1,000, and if he dies I will give him a decent burial. But I don't believe there is any such man as Dr. H. S. Tanner, of Minnesota. I am inclined to think that the whole thing is a huge Western joke."

Dr. Tanner, however, proved that he was no fiction and no joke by arriving in New York, in May, and calling at Dr. Hammond's office, telling him that he was ready to begin the fast. Dr. Hammond told him he could not talk then, as it was his office hours, but made an appointment at his house, where he expected members of the Neurological Society. When Dr. Tanner called at the appointed time, there was nobody there, and Dr. Hammond had gone to the theater. Four days afterward Dr. Tanner received a note offering an apology, and making an appointment five days later, at the rooms of the society, but when Dr. Tanner called, it was the same thing, nobody there—the society having adjourned for the summer months. The next day Dr. Tanner called for an explanation, and Dr. Hammond proposed he should go into his house and perform the fast there under watchers appointed by him. Dr. Tanner refused this, and insisted on the original proposition, when Dr. Hammond suggested a postponement until fall, to keep the fast during the meeting of the Neurological Society, saying: "This is a capital idea, for in case of success, you will achieve not only a local but a national reputation."

As Dr. Tanner objecting to the delay and expense, made then arrangements to begin his fast at once at the United States Medical College, selecting watchers for himself, letting the college authorities also appoint reliable watchers, and invited Dr. Hammond and all medical societies in New York to do the same.

Nearly twenty days after the last interview with Dr. Hammond, Dr. Tanner received a letter ante-dated June 1, but marked, according to postmark, June 19, mentioning that the Neurological Society was to hold a special meeting to arrange about his fast. We will pass over a very pointed correspondence which ensued, as of no interest to the general reader, nor the conversations with interviewers from the press, which were published at the time, and which showed a great deal of bad feeling all round, and which surely was not favorable to Dr. Tanner, as a preparation for the severe ordeal which he intended to pass through. But matters had all been arranged, and the great fast began at noon, June 28, in the lecture rooms of the United States Medical College, 114 and 116 E. Thirteenth Street, New York city.

It may be well to state here that it was not Dr. Tanner's first experiment in this line. He had for many years restricted himself to a very plain and frugal diet. He never drinks tea, coffee, or liquor of any kind, and does not use tobacco in any form, and he claims (and this with good grounds) that every man would be healthier by following this example. He is very earnest in his endeavors to prove what he calls the "errors of physiology," and holds that most diseases of mankind are due to eating too much and too often; and being himself subject to a tendency to gastric derangement, he had found that total abstinence from food always cured him. Having been detained late in the night by professional duties, he felt seriously indisposed, July 16, 1877, at the residence of Dr. Moyer, in Minneapolis, Minn.; he drank a quart of milk, and the next day a pint more, and from this time no food until August 29, exactly six weeks, or 42 days. The way this came to pass was as follows:

On the 18th of July he was satisfied that he was suffering from gastric fever, induced by abrupt changes in diet, during the last few weeks, and he resolved, in accordance with his regular custom, to fast until better. He did not leave the house of his friend, Dr. Moyer, nor did he eat anything whatsoever, but drank plenty of cold water when he wanted it. After ten days the fever had disappeared, he felt much better, and he renewed his usual walk of one to three miles twice a day, while Dr. Moyer remonstrated against what he called suicide, and food was brought so as to break his fast. Dr. Tanner, however, when the food was within his reach, resolved to wait, and to try how long he could stand it. No persuasion could induce him to discontinue his experiment to find out the effects of a fast, prolonged as much as was possible to him, and he found that, notwithstanding he sometimes walked nine or ten miles a day, he did not suffer much from fatigue or other inconvenience, except a disagreeable gnawing sensation in the stomach. On the thirty-eighth day, after considerable fatigue, having been out all day on a pedestrian excursion, he came home sick, and had considerable retching, straining, and tendency to hiccough. This alarmed his friend, Dr. Moyer, who, when three days more had elapsed without the inflammatory symptoms subsiding, convinced him to swallow small doses of milk, and allow this to be thrown up. The milk was retained but a few minutes each time, but it quieted the irritation, and the next day, the forty-second of the fast, it was retained, and his appetite so stimulated that, having drunk all the milk in the house, he went himself, late in the evening, to the market to drink more. He found his appetite ravenous, and in addition to the milk he drank, he ate five large California pears and half a good-sized watermelon. Both doctors were frightened, expecting business during the night, but no inconvenience whatsoever was the result, and the amount of provisions he made to disappear during the next four weeks was so large, that both doctors agreed there was no economy in fasting, but the contrary.

Of scientific data furnished by this fast there were none; neither loss of weight, water drunk or voided, velocity of pulse, or other phenomena recorded, as the fast was only begun as an experiment to cure his gastric fever, and continued to see how long he could stand it. As there was no intention to make his fasting known to the public, no preconcerted plan had been arranged, but as it was no secret there it was talked much about, so much incorrectly, that Dr. Moyer was induced to publish a statement in the Minneapolis *Free Press*. From this moment Dr. Tanner received many letters intended to throw doubt upon his veracity, especially from medical men, and the doctor, feeling his reputation injured, published a communication in which he summed up many well authenticated cases of prolonged fasting during sickness and otherwise, proving that the assertions of impossibility proceeded only from want of information among the doubters in regard to the records of their own profession, while as a final proof, Dr. Tanner proposed to fast again under the strictest watch, for the sum of $5,000, to be applied for charitable purposes toward unfortunates of the female sex, while he concluded his communication with the remark that "skeptics who regard my experiment as of no consequence don't know how much discomfort I suffered before from dyspepsia, until I cured myself by the fast, and now feel as if I had a totally new stomach."

From that time the papers throughout the West gave often accounts about protracted fasts. Dr. Tanner received many letters about it, and the literature of fasting became very familiar to the reading public. At last the interest began to die out, and Dr. Tanner continued his medical practice quietly until he became prominent again by his late fast in New York City, to which he was induced by Dr. Hammond's offer of $1,000 to Miss Fancher, as above explained.

This fast began June 28 at noon, after arrangements had been made to make it perfectly fair and honest, to make deception an impossibility, and if possible to cause it to contribute to science and practical medicine. These arrangements had not been heralded before the public, nor even before the medical profession; nobody outside did know much about them, hence the cry of the perfect uselessness of the whole proceeding in which many physicians indulged.

The first thing done was to strip Dr. Tanner, for the double purpose to examine his physical condition and to see if any food was found in his clothes or satchel. Nothing was found except a copious layer of fat or adipose tissue around his body, sufficient to keep him alive for a winter season, if like a bear he could have been induced to a winter sleep. He measured 40 inches around the breast, 39 around the abdomen, and 22 inches around the thigh. His weight was found to be 157½ pounds, thus above the average for his size, which was 5 feet 3 inches.

This was inscribed in the diary prepared to record the history of the fast, and signed by Drs. P. H. Vander Weyde, David Ward, R. A. Gunn, William L. Tuttle, A. E. Falkner, and Joseph R. Buchanan, who had met for this examination.

This diary states that on the first day he went to bed at 9 P.M. The bed was thoroughly searched. His pulse was 82, full and regular. On the second day he rose at 7 A.M. At noon had drunk fifty-seven ounces of water during the preceding twenty-four hours. A letter was received from Dr. Gray, vice-president of the Neurological Society, offering arrangements for the fast and have it tested by experts. Answer was sent that the fast had been commenced, with an invitation to members of the society to join in the watch, some of which did so a few days later. On the third day Dr. Tanner said he felt very hungry; he began to dispense with drinking water, only rinsing his mouth with it; had lost in weight four and a half pounds. On the fourth day he felt better, conversed freely, read the morning papers, and wrote several letters. The mail brought quite a correspondence, as he was beginning to be largely noticed. It was agreed that the watchers should open the letters before giving them to Dr. Tanner, so as to be sure that no concentrated food was contained in them.

Nothing of interest happened for several days afterward. Dr. Tanner abstained from water also, as an experiment; only rinsed his mouth and used a wet towel around his head. After a week Dr. Vander Weyde, who had charge of the chemical analysis to detect any changes in the water voided, wrote in the record book: "I was surprised to find Dr. Tanner so well. I expected a change, but found none. This expectation was based on great changes I found in the water voided, in which there is a surprising diminution of urea."

After the first week doubters in Dr. Tanner's honesty, who rented the large hall which had been set apart for him, were forced to admit that everything was conducted fairly. But many predicted that he could not hold out another week, as the loss of two pounds a day would use up all the tissue he had to spare. It was now announced that the *Herald* had made arrangements that the reporters should join in the watch, which pleased the faster exceedingly, as it would add to the conviction of the public that everything was conducted with honesty.

The physicians who thus far had kept the watch belong to the so-called eclectic school, which means that notwithstanding they are graduates of the ordinary regular colleges, they share not in the prejudices of the allopaths against other medical schools. On the ninth day some allopaths and members of the Neurological Society completed arrangements to keep up a watch, and provided a book for their own observations, expressing regrets that they had not done this before. On this day Dr. Tanner stated that he did not feel hungry any more, and was now accustomed to fasting.

On the tenth day he complained much of the heat, and had his cot elevated to the open windows in front of the building. He slept little and asked frequently for wet sponges. On this day Dr. Bradley accused Mr. Johnson, one of the watchers, of taking something out of his pocket and giving it to Dr. Tanner, and said he believed it was food; further, that the value of the experiment was destroyed, and that it was useless to go any further. When it was proved that the something given to Dr. Tanner was a wet sponge, he said he believed it was wetted with beef tea. Dr. Wash suggested to give Dr. Tanner at once an emetic, which was earnestly urged by Dr. Tanner as a sure means to prove that he had taken no food. Dr. Bradley would not agree to this. Dr. Tanner, with tears in his eyes, begged Dr. Bradley to do him justice, and said: "Double your watch, and if I take food you can demonstrate my inability to accomplish my task long before the expiration of the remaining thirty days." Dr. Bradley, however, continued to talk boisterously and use profane and slang language; but when Mr. Johnson explained that he took his handkerchief out of his pocket to wipe his fingers, which had been wetted by the sponge he gave to Dr. Tanner, and when this was verified by all others present, Dr. Bradley left annihilated and did not appear any more during the rest of the watch.

Curious to relate, that Dr. Vander Weyde, who had not been present for several days, but daily received samples of the urine voided for microscopic inspection and chemical analysis, noticed at that time a striking increase in the amount of phosphates secreted, proving an abnormal waste of phosphorus, usually the result of mental and nervous excitement. And without knowing anything about the Bradley disturbance, he wrote a note to Dr. Gunn, stating he feared that the great danger of Dr. Tanner was in the waste of the nervous and brain tissue, and that it would be advisable to give him mental relaxation by some kind of amusement.

By the abstinence from drinking the amount of water voided had decreased considerably, and this had caused a great concentration of the same, which made the sudden increase in phosphatic salts (easily recognized under the microscope by their peculiar crystalline shape) still more conspicuous.

In the meantime Dr. Tanner declared that this Bradley disturbance was worse for him than five days' additional fasting would be, and he called for water again, of which he drank four ounces; and on the next day he and Mr. Johnson made affidavits under oath that Dr. Bradley's suspicions were unfounded.

He continued without water, and on the fifteenth day unfavorable symptoms, evidences of cerebral disturbance, were manifest. He was urged to take water, and promised to do so if not better the next day; his pulse had risen considerably, and varied from 98 to 107, and on the next day he was worse; he drank ten ounces three times—thirty ounces in all. The next day he was much better, pulse fell from 108 to 95, and he took his first carriage drive, always accompanied by three or four of his watchers. This did him so much good that he expressed a desire to have two such drives, one in the early morning, and one late in the afternoon; and these were, of course, provided for and indulged in for the rest of the fast when the weather was favorable.

From this time—the eighteenth day—he was generally in much better condition, and was often entertained by musical visitors, who sang or performed on various instruments for him; he also received many floral offerings, all of which were very gratifying to Dr. Tanner, as, like every other refined man, he is very fond of music and flowers.

On the twenty-first day he walked to a photograph gallery, half a mile off, to have his picture taken. On the twenty-third day he wrote letters, and had a conversation with Dr. Miller about the physiological effects of electric currents after certain nerves had been cut, and his mental activity continued bright until the twenty-sixth day, when he became weak and restless, and complained of nausea; but the next day he was better, and showed his wonderful powers of recuperation, as he was extensively interviewed by reporters, and gave his opinions upon spiritualism, religion, etc., with the request to publish them.

On the thirty-first day he had eructations of gas, attended with nausea, vomiting water, mucus, and bile, and at 11 P.M. an "alcohol sweat" was administered, which relieved him, as he had taken a cold during his carriage drive in the early morning. He expressed no fear for his nausea, but warned his medical watchers to look out when hiccough sets in.

In regard to this "alcohol sweat," some learned physicians who were anxiously looking for some source of nourishment, suggested in the newspapers that Dr. Tanner was being nourished by alcoholic vapor baths. Justice requires the statement that he never took any alcoholic vapor bath, but

simply sat on a chair, with a rubber blanket around him, while an alcohol lamp burned under the chair until perspiration was produced. That was all, and it is, indeed, difficult to conceive how a man in a condition of starvation can obtain any nourishment by sitting for a few minutes over a burning alcohol lamp.

This assertion is on a level with another one, that Dr. Tanner obtained animal food from the animalcula in the water he drank, and that for this reason he preferred the water from the spring in Central Park, as this was richest in animal life. The fact is, however, that this very spring water was exceptionally free from animalcula, which Croton water is not. But, in any case, such assertions conform to the most extreme homeopathic doctrine, while the most curious fact is that they did not emanate from homeopaths, but from some physicans of a school antagonistic to homeopathy.

On the thirty-third day Dr. Tanner read the report that he had died. This annoyed him greatly, but some other published articles about his fast consoled him—among them, one in the *American Medical Journal* of St. Louis.

On the thirty-fifth day he vomited bile several times, and a mustard plaster was applied over his stomach, which relieved him. It being suggested that he would have trouble when he began to eat again, he said that he knew better, and that all his troubles would be ended as soon as he took food in his stomach. That day he received the following cablegram from Paris:

"DR. TANNER, Clarendon Hall, 13th Street, N. Y.:

"Don't waste strength driving out. Shut off all spectators; have only your doctors and attendants. Standard telegrams republished everywhere, and read by everybody. Your experiment watched with great interest by scientists; ridiculed by fools. Hot weather is against you. Courage, brave fellow; hold on! Wish you success.

"DR. J. MARION SIMS."

A cry was set up by all doubters, and even leading papers, that this dispatch was bogus. It was especially Dr. Hammond who, when interviewed by a reporter about it, expressed most decidedly and vigorously his opinion that it was a most stupid game of Dr. Tanner's friends, a pure concoction, a fraud; that Sims (whom Hammond called his friend) would never send such stuff as that, and if he were guilty to cable such trash, he (Hammond) would endeavor to forget him; that the whole experiment of Tanner was useless; that it was not properly watched nor scientifically conducted, etc. These latter opinions were shared by all those who imagined that if they themselves did not conduct the whole affair, nobody else could do it—a kind of conceit very common among a large class of people of all kinds, and especially among a certain class of doctors.

Unfortunately for Dr. Hammond, it was proved by an inquiry, made per telegraph by the *Herald*, that Dr. Sims indorsed the dispatch as sent by him, on which indorsement the *Herald* remarked: "How the two gentlemen must feel toward one another, Dr. Sims saying the experiment is only ridiculed by fools." Dr. Hammond having ridiculed it all the time, and Dr. Hammond declaring the dispatch to be trash, and that he would endeavor to forget his friend Sims if he could really "cable such trash." Then a change appears to have come over Dr. Hammond; he became convinced that Dr. Tanner would succeed, and that the experiment was fairly conducted, and he wrote to Dr. E. Hoebe a letter (which the latter brought to Dr. Tanner) in which he stated that: "1. He thought the watching had been fairly conducted. 2. That Dr. Tanner had faithfully abstained from food. 3. That he had succeeded better than Dr. Hammond expected. 4. That there have been other long fasts, but that this is the best authenticated one. 5. That Dr. Tanner's organism is like that of other people, as he suffered as others would have done. 6. That he has shown that the symptoms of inanition produced in other fasts are fraudulent. 7. That he proved the impossibility to go without water for a long time. 8. That he has great pluck and endurance, commanding admiration. 9. That he should stop at once, to prepare his stomach for watermelon on the fortieth day. 10. That further perseverance in the fast is connected with great danger. 11. That the offer to go for thirty days without food or water is still open, but it is hoped he will not accept it. 12. That the investigations have been superficial and restricted; the exhalations from skin and lungs should have been analyzed, and the weighing was imperfectly performed. 13. That the scientific results are not what they should have been, but that enough has been shown to cause us to modify our view in regard to the effects of inanition on the human body.

(Signed) W. H. HAMMOND."

In regard to the last two items it should be considered that Dr. Hammond was in ignorance of what was being done scientifically. The weighing was very carefully done, not only of Dr. Tanner, but of all the water he drank and voided, while of the latter a microscopic and chemical analysis was almost daily pursued. To do this with the exhalations of lungs and skin was not so practical and less necessary, as these chiefly are carbonic acid and water, and the products of the slow combustion of the carbon in the fat of the body keeping up the animal heat, so that the most always normal condition of the latter was a sure index that the combustion did not vary much, and consequently neither its products exhaled by the lungs and skin. The temperature of the faster, taken in the mouth, was most always between 98¾° and 99¼°, and very seldom descended to 98° or ascended to 100°.

On the thirty-sixth day Dr. Tanner was tolerably well, but on the thirty-seventh he vomited bile, and complained about being annoyed by the visitors, and feeling weak; the thirty-eighth day was one of the most trying; he suffered from nausea, and often vomited bile; rubbing of abdomen and legs with mustard footbaths relieved him. It was nearly the same on the thirty-ninth day, when more than six hundred people came to see him, and he went frequently down to the large hall, with bright and cheerful looks. On the fortieth day, before noon, at the close of the fast, nearly all the watchers were present. He had slept well the previous night, but was evidently glad that the end was near. Numerous presents arrived of all such kinds of food which the senders kindly supposed would be best to break the fast with, while he cheerfully showed himself to all who came. In the large lecture room a kind of fence had been made at the beginning of the fast to prevent visitors to crowd too close around Dr. Tanner. It was, however, found that he was often uncomfortable within this inclosure, and one cot had been placed on the gallery at the south side of the room (rear of building), on a table, as shown in engraving, No. 242 of SUPPLEMENT, and so close before an open window that it was sometimes feared he would tumble out during his sleep. In his reception room the writer of this account found him an hour before the close of the fast, with a beautiful peach in his hand, which he said would go first in his stomach. Two or three minutes before twelve he began peeling the peach, and when the noonday whistles of the surrounding factories blowed it was eaten in full view of the thousands which were crowding the street, and cheered him in the same style as they would cheer a visiting President or Governor. Dr. Tanner then waived his handkerchief to the enthusiastic crowd in the street and passed in the large hall under the sound of music playing "See the Conquering Hero Comes." The cheers, however, drowned the music, and he stepped on a platform arranged in the middle of the inclosure, and which was loaded with many kinds of eatables, especially watermelons, which are his favorites. He drank freely from milk just brought in from a reliable farm, then he asked for watermelon. The physicians present remonstrated, but in vain. He said, "Let me alone; I know my own machine: I am now going to run it myself," and almost half of a large watermelon disappeared. He then went to take a ride in the carriage waiting in front of the door, and at his return commenced eating again. The quantity of food he made to disappear was appalling, and disgusted those who had before admired him for his excessive frugality. Milk, apples, enormous quantities of watermelon, beaf tea, potatoes stewed in milk, several beefsteaks, and at last Hungarian wine and English ale. Everything appeared to be readily digested and absorbed, contrary to the general expectation as well of physicians as of others, that great trouble would ensue when food again first entered a stomach which by a long fast had become unaccustomed to digest.

This case appears to teach an important lesson, namely, that the customary treatment of persons who have been suffering from starvation, to give them but small quantities of milk and brandy at long intervals, is all wrong. It is a fact that many die under this treatment after they have been rescued. This has been ascribed to disorganization incident to the long abstinence from food. It now appears more likely that it is the erroneous treatment, that in such cases there is no time to be lost, and the stomach should at once be filled with pure milk, fruit, meat, and other kinds of wholesome food, when it will be able to resume its functions at once in place of being stimulated with brandy, which, by the way, contains no nourishment whatsoever, and not even a tonic. Brandy is for man what the whip is for the horse; it can make the horse go, provided there are oats at the bottom of it; without the oats the whip is of no use, and, without a bottom layer of plenty of good food, brandy does only injure a man. Dr. Tanner did not use wine or beer until after several good hearty meals.

These remarks were elicited by a report which was first now published in the daily papers, of a man who had hidden himself in a lumber yard and was found after some twelve days in a starving condition. The physician here again administered small quantities of milk and brandy, an incongruous mixture, only digestible by a stomach in normal condition by the presence of solid food, but surely hurtful to a weak, starved stomach. The physician, according to the erroneous, traditional, unwise custom, gave this in place of a good square meal, as, after the Tanner experiment, we know now to be the correct treatment for the future for cases of starvation. Twenty-two hours after the close of the fast the bowels operated for the first time in forty-one days. This was one proof that no food had been taken. He was gaining now in weight at the rate of five pounds per day, and kept this up for several days, when his ravenous appetite moderated, and he ate considerably less, and remained stationary in weight for some days, when a slower increase set in again.

Another proof of the honest performance of the fast was the chemical analysis of the water voided, which was measured daily, as well as the water he drank. Two principal waste substances are carried off by the kidneys—nitrogenized substances from the waste of the muscular tissues, and phosphorized substances from the waste of the brain and nerves. In the usual conditions these substances are derived from two sources—the excess of nutrition by food and the actual waste of the system. When the supply of food is cut off the substances secreted represent the waste only. In Dr. Tanner's case the amount of nitrogenized substances secreted in this way diminished day by day, showing how nature economized the waste, until they represented scarcely one-tenth part of the original amount, while twenty-four hours after the break of the fast the amount had suddenly increased and more than tripled. The behavior of the phosphatic secretion has been mentioned before.

A most interesting investigation of the changes in Dr. Tanner's blood has yet to be noticed. During the last hour of the fast a part of a drop of his blood was placed under the microscope and examined with a suitable magnifying power. It was seen that every corpuscle, otherwise smooth in the normal condition, was covered with a kind of fungoid growth, which appeared to flourish at the expense of the corpuscles, as they were smaller than usual (in place of 1-3,600th of an inch in diameter they averaged about 1-5,000th), and some had a ragged, broken appearance. We borrow a representation of this appearance, engraved after a drawing made at the microscope, and published in the SCIENTIFIC AMERICAN of August 28, in juxtaposition to the normal corpuscles, so as to show the striking contrast. The appearance is very similar to that seen in specimens of blood of patients who died of typhoid fever, and of which occasionally slides may be found prepared for the trade in pathological objects for the microscope. Korel found the same appearance in the last stages of consumption, in aggravated forms of scrofula, and other ailments which tend to deteriorate the blood.

It may be interesting to remark here that there is a connection between this gradual deterioration of the blood during the prolonged fast and the bilious symptoms and vomiting of bile taking place during the last days of the experiment. The function of the liver appears to be the secretion of the effete blood corpuscles and the change of them into bile; when the number of such corpuscles became abnormally large, the liver secreted much bile, became overtaxed, and bilious symptoms necessarily ensued.

1.

Appearance of the Corpuscles of Normal Human Blood.

2.

Appearance of the Corpuscles of Dr. Tanner's Blood after Forty Days of Starvation.

Very far from Dr. Tanner's starvation experiment being useless to science, it was not only useful to science as long as it lasted, but for some time afterward, giving a fine opportunity to observe the gradual improvement in his blood. It showed that blood drawn from the capillaries alone, near the skin, showed a far greater number of defective corpuscles than blood obtained by a deep puncture reaching blood-vessels from which it ran more freely. It might, of course, be expected that newly formed corpuscles, and corpuscles restored to their normal condition in the apparatus where the blood forming is going on, will be most abundant in the arteries which have their supply direct from the heart, while the most defective will linger longest in the capillaries until they can be no more useful, and then are carried with the rest of the venous blood to the secretory organs, to be eliminated from the circulation. It appears that this elimination is not going on at a very rapid rate, as more than a week after the close of the fast the blood corpuscles were not all normal yet. The restoration going on in two ways, a healing and restoration of the affected corpuscles, which were seen in all stages of improvement, and the formation of new ones in place of those destroyed by the fungoid growth, and of which the fragments were often quite frequently seen.

We close this account with an extract from the observations, condensed to every fourth day, in a tabular form, from which it will be seen that the experiment has by no means been useless to science.

TABLE OF PHYSIOLOGICAL OBSERVATIONS MADE ABOUT DR. TANNER'S FAST.

Day.	Weight.	Pulse.		Temperature.		Respiration per minute.	Ounces of water drunk per day.	Ounces of water voided per day.	Grammes of urea in water voided per day.	Phosphates in water voided.
		Highest.	Lowest.	Highest.	Lowest.					
1	157	88	82	99	99	16	56	17	29	Normal.
4	150	84	84	98	98	16	0	19	16	"
8	142	84	77	98	98	14	0	13	13	"
12	138	96	80	100	99	13	0	14	12	Abnormal.
16	132	108	95	98	98	15	29	19	11	Increase.
20	135	82	86	99	98	16	47	45	10	Normal.
24	132	89	72	99	98	15	30	21	9	Diminished.
28	130	73	72	99	99	16	20	10	9	"
32	127	72	72	98	99	15	12	10	9	"
36	125	74	74	99	99	15	24	15	7	"
40	122	92	82	99	99	17	18	9	6	"
										"
End of Fast.		96		100		19	Milk.			
44	142	74	74	99	99	16	100 About.	30 About.	40 About.	Normal.

SALICYLIC ACID FOR THE CURE AND PREVENTION OF DISEASES IN CATTLE AND LIVE STOCK.

MANY useful observations have been made recently in Germany with regard to the cure and prevention of disease in cattle and live stock generally, by an appropriate application of salicylic acid. We shall endeavor to present to our readers, in as condensed a form as possible, some of the principal results which have been obtained hitherto, and the means by which they have been brought about.

I.—TREATMENT OF ERYSIPELAS, ANGINA, AND VARIOLA IN SWINE.

Erysipelas has been found to subside and disappear altogether on administering 7½ grains per head of salicylic acid in an aqueous solution of 1 per cent. every half hour for four hours—that is, in eight times. Each dose of 7½ grains is dissolved in about two pints of water; or this dose may be given only three times a day, namely, in the morning, at noon, and in the evening until the appetite of the animal returns, which usually occurs from half a day to two days after the treatment has commenced. It is then sufficient to mix with the food 5 grains of the acid *per diem* and *per* head, previously dissolved in water.

Angina in pigs, whether epizootic or sporadic, is treated in the same manner, but the dose is doubled. It will require 15 grains *per* head, administered every half hour, this quantity of acid being dissolved in about two pints of water. If the animals still show signs of appetite, which is sometimes observed at the commencement of sporadic croup, the salicylic acid is given in conjunction with curdled milk.

Variola.—In case of variola, every couple of pigs get 5 grains of salicylic acid dissolved in two pints of water and mixed with the food. After three to five days' treatment the cough ceases and recovery sets in. An important condition of success in erysipelas and croup is to administer strong doses at the onset—that is, the very moment that any suspicious symptoms break out. The size or weight of the animal should be taken into consideration in order to fix the dose with absolute accuracy, but this is not indispensable.

Pigs fattening for market are given 5 grains of salicylic acid dissolved in water *per diem* and *per* head, in order to improve the appetite and vivacity of the animal. The same dose is administered daily to animals purchased from drovers,

on account of the uncertainty which must exist with regard to the sanitary conditions of such vagrant herds.

Rheumatism and Lameness.—Pigs which are stiff or lame from the effects of bad food or cold have been cured with the same aqueous solution of salicylic acid in from four to eight days.

The best vessel for pouring such solutions into the gullet of the animal is a *stone jar;* glass bottles must be avoided, as they almost invariably get broken.

The feeding of stock upon the *refuse of distilleries* and of sugar factories, such as potato, cereal, and beetroot refuse, and upon *green clover*, entails a variety of ailments. The refuse of spirit or sugar works is full of ferments and bacteria, which are the causes of severe diseases. We have the following testimony of a breeder on this subject:

"A valuable bull, recently purchased, was enormously swollen out after partaking of green clover. All the usual remedies were speedily applied, but without avail; and the veterinary surgeon was about to operate, when some one proposed that salicylic acid should be tried. Thirty grains of the acid were administered at intervals of half an hour, and in a very short time the beast was out of danger. In fact, after the first dose, the internal troubles became quieter, the pressure on the waist subsided, and the gases were discharged from the bowels.

"When fattening cattle on the refuse of distilleries, etc., I have always been in the habit of mixing salicylic acid with it, at the rate of 15 grains of the acid to 88 pints of the original refuse *per* head of cattle, and I have thus avoided attacks of flatulency."

The use of this refuse as food often entails the formation of *microscopical growths* in the vagina of the cow. In such a case injections of a tepid solution, containing 15 grains of salicylic acid to 2 pints of water (or 1 in 500), was found to give speedy relief.

Many favorable reports are to hand with regard to the use of salicylic acid for *diarrhea in calves*. In these cases about 7 grains *per* head and *per* day has proved to be an efficacious remedy.

It has been long known that *diarrhea in cows* is often a precursor of abortion; a timely use of salicylic acid is therefore doubly important in such cases. If the udder of the cow be inflamed, 15 grains of salicylic acid dissolved in about 4 pints of water must be administered as a beverage three times a day, and at the same time the udder may be rubbed with unsalted lard in which a few grains of salicylic acid powder have been previously dissolved by the aid of warmth and well mixed. *Milk fever* has been cured in sows by administering every half hour, for three hours, 7 grains of salicylic acid in solution, and by anointing the swollen udders with the salicylated lard, as just mentioned. Other domestic animals have in the same manner been cured of or protected from similar attacks of illness.

Salicylic acid is also of great use to the breeder of poultry. For instance, the diphtheritic affection commonly called "*the pip*" in hens, and the *epizootic septicæmia* of geese, which has a pleuro-pneumonic character, will be averted by the addition of some of the concentrated solution of salicylic acid to the water in the farmyard where the fowls or geese are accustomed to drink.

The doses of salicylic acid recommended in these various cases must, of course, always stand in some proportion to the size or weight of the animals; for instance, if 15 grains is prescribed *per diem* for a cow, a bull would certainly require 22 grains, while a pig which is being fattened will not want more than 5 grains.

GLANDERS IN THE HORSE.—Glanders and skinworm are one and the same disease; the first applies to the attack in the nose, eyes, and throat, while the second denomination alludes to the worm-like sores on other parts of the body. It is a fact, according to Professor Zürn, that glanders results from the invasion of a microscopic organism, and the infection is propagated in the system by the reproduction of this *microbe*, which takes place at a prodigious rate. Gerlach has recorded (in the "Annals of the Royal Veterinary College of Hanover," 1868) having witnessed an improvement in the health of the infected animals after the internal administration of carbolic acid, and he recommends injections of a 1 *per cent.* solution of carbolic acid in water, with dressings of oil containing 10 *per cent.* of the same substance. It was asserted that a horse could bear 23 drachms *per diem* for ten days! Other authorities, more particularly Weiss and Zürn, are by no means of the same opinion, and the latter do not appear to have had any results with carbolic acid.

On the other hand, salicylic acid *has* proved successful in cases of incipient glanders, and it should be used whenever there is the slightest suspicion of that dreadful disease, for there is no fear of poisoning as with carbolic acid. There is a wide field here for useful experiment.

When glanders has appeared its spreading must be checked by the following means:

1. Change the stables.

2. Before taking the horses into the new stables the animals must be washed with a tepid aqueous solution, prepared by dissolving salicylic acid in boiling water, and diluting the solution with tepid water, so that the wash contains 3 parts of salicylic acid for 1,000 parts of water. The nostrils, mouth, and nose must be especially well washed, and for the eyes a separate sponge and cloth must be used.

3. Repeat this washing three times a day.

4. The old stables infected with germs of glanders must, of course, be throughly well washed in every part with the aqueous solution of salicylic acid, and fumigated as usual. After three days' cleaning the walls should be whitewashed.

5. The mangers and gratings must be washed with the hot concentrated solution of salicylic acid and allowed to dry, without rubbing, by exposure to the air.

It has lately been found that the *mange in sheep* can be cured by dressings of salicylic ointment, combined with internal doses of the salicylic acid powder or its solution.

With regard to the use of salicylic acid as a preventive of *pleuro-pneumonia*, Herr Otto Ludloff, of Friedrichswerth, near Gotha, states that he believes it an efficient remedy, not only against pneumonia, but also croup and *diseases of the blood in general* in horses, cattle, pigs, etc. After several months' use of the acid he had only two cases of croup among his pigs, and these cases were promptly cured by the administration of stronger or more frequent doses. During this time he had not a single case of pneumonia, though it is very general in his neighborhood.

Symptoms of pleuro-pneumonia and croup having broken out among his cattle and swine, Herr Ludloff gave 20 *grains daily of salicylic acid per head*, and since then he has had no loss whatever. He now keeps fourteen horses, fifty head of cattle, twenty-four large pigs, fifteen rams, and he gives them daily from 3 to 3½ ounces of salicylic acid. This gentleman writes: "I shall publicly and most emphatically recommend this acid to all farmers."

His mode of application is the following:

"In the morning I put 3 to 3½ ounces of salicylic acid into a vessel containing 2¼ gallons of water, dissolve the acid by boiling, and add this in proportion to the different troughs. It is necessary that this operation be performed by a perfectly trustworthy person. As long as my sheep are in the field I do not give any salicylic acid, but during the winter, when in the stables, I administer 20 grains per ten head with great success."

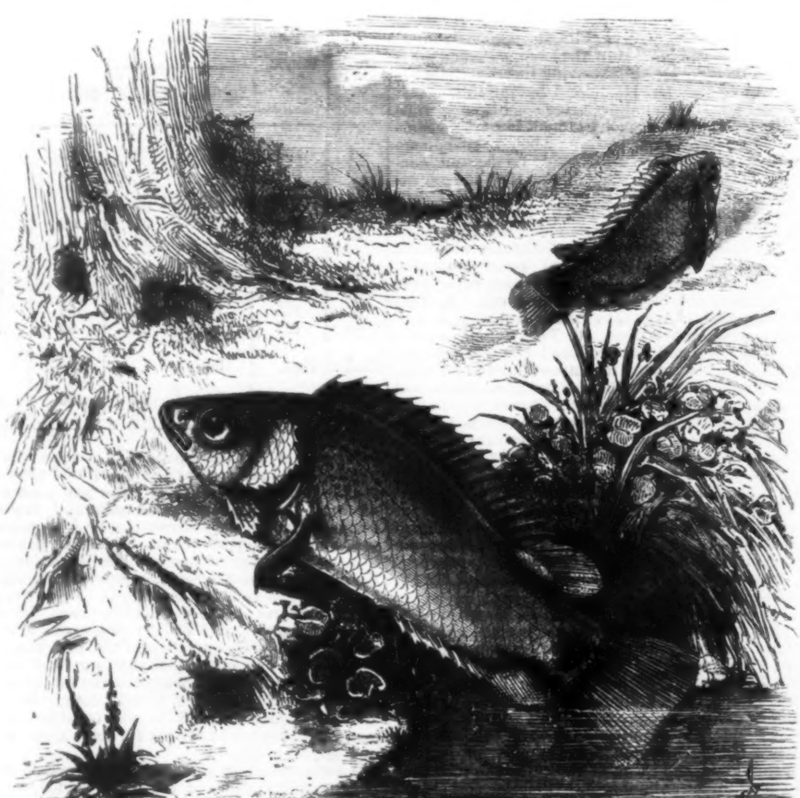
Having given salicylic acid to his stock daily for the last two and a half years, he has not lost a single head of cattle or horses, and the *Board of Trade of Saxe-Coburg-Gotha* has published his observations.

We see, then, that in veterinary practice and in the farm, as in medical practice generally, salicylic acid has secured a recognized position, whether used in aqueous solution, alcoholic solution, or in the form of ointment. In the latter form it has been found efficacious in the case of *sores* arising *from pressure* of the saddle or harness; and there is a striking illustration of its harmless nature in the fact that, by properly and carefully treating *beehives* with salicylic acid, most diseases of *bees*, especially the so-called "*foul-brood*," are successfully prevented or cured: A slow evaporation of the acid on a tin plate gently heated by means of a small flame will immediately neutralize and destroy the virus without injuring either the brood or the honey.

But one of its greatest achievements is certainly the prevention of *pleuro-pneumonia*, already referred to, a scourge which has never been checked before, and against which it has proved as efficacious as in *milk fever, diarrhea, foot and mouth disease, strangles*, and *glanders*, by the simple methods enumerated above. The discovery of such an excellent remedy, which is at the same time safe, efficacious, and easy to apply, cannot be too highly valued.—*Monthly Magazine.*

THE CLIMBING PERCH.

THE fresh waters of India and the islands of the adjoining archipelago, as well as those of Southern Africa, are inhabited by a family of fishes of more than usual interest, which is due not only to the food value of some of its members, but also the singularity of their habits—their power of enduring a prolonged stay out of their native element. This family is known scientifically as the *Anabantidæ*, or fishes with labyrinthiform branchiæ. The family name is derived from the generic designation of one of the chief genera, *Anabas*. The Anabantids vary considerably in form and peculiarities of structure, but in general appearance resemble such of our fresh-



THE CLIMBING PERCH.

water fishes as the sun-fishes, grass bass, black bass, etc. In other words, they are oblong, laterally compressed fishes, covered with scales of moderate size; with the ventral fins thoracic, with the dorsal and anal fins with spires anteriorily and generally in large numbers; and with the uppermost elements of one pair of the gill-bearing arches peculiarly modified; that is, the uppermost element of each side, instead of being straight and solid as in most fishes, is excessively developed, and provided with several thin plates or folds erect from the surface of the bone and from the roof of the skull to which the bone is attached. These plates by their intersection form chambers, and are lined with a vascular membrane which is supplied with large blood vessels, and it was formerly supposed that the chamber referred to had the office of receiving and retaining supplies of water which should trickle down and keep the gills moist, and such was supposed to be the adaptation for the sustentation of life out of water. Some experiments, however, tend to throw some doubt upon this alleged function. The climbing perch (*Anabas scandens*, Cuv. and Val.) is perhaps one of the best known species of this family of fishes, and inhabits the fresh waters of India, Malaysia, and the Philippine Islands. This fish (shown in the annexed figure) has an oblong and slightly compressed body, with a rounded head, and inflated cheeks and gullet. It is of a rifle green color, lighter in the abdomen, with four dark vertical diffused bands passing from the back to the abdomen. In the young fish a dark spot is generally present at the base of the tail. The fins are dark green, but in clear water tend to become reddish. As to its habits, Dr. Francis Day, in the "Fishes of Malabar," says that the climbing properties attributed to it in other parts of India and Ceylon are fully believed in by the inhabitants of Malabar. It is certainly with difficulty, says he, that they can be retained in a vivarium, since, unless it is covered, or its summit is upwards of a foot above the water, they invariably escape. They are able to progress along the ground in two ways; either by lying flat on their sides, flapping their tails, moving their pectoral fins, or else chiefly by the aid of the latter fins—first one being advanced and then the other. They can erect their fins and likewise their scales at pleasure, even down to those along the bases of the caudal fin. This power of erection, especially as it also exists in the gill covers, would be of great assistance did they employ the latter in climbing. The hollow superbranchial organ, with from two to six laminæ (the number of which depends on the age of the specimen), with fringed valances, enables the "climbing perch" to retain water for a considerable time, so that it can moisten its gills and live while out of its native element. Hamilton Buchanan observes that he has known it to retain vitality under these conditions far six days. That it travels from pond to pond when its means of subsistence fail is a well known fact; but that it buries itself in the mud as tanks dry up, and remains there until the monsoon of the next year fills them with water, is a statement that requires further research before it can be accepted. These fishes being common in most pieces of fresh water in Malabar, and being esteemed good eating by the natives, are much fished for. The natives when catching them invariably bite their head to destroy life. On one occasion, says Surgeon Day, this practice led to a fatal result: the fish having slipped down the throat of the fisherman it could not be withdrawn, owing to the erectile nature of the gill-covers and scales, and the man died of suffocation before reaching the hospital.

THE INTERNATIONAL BENCH SHOW AT BERLIN.

ON the 21st of May, 1880, the International Bench Show at Berlin was formally opened by Dr. Bodinus, in presence of the royal protectors of the Exhibition and a vast assemblage, who filled all the passages of the Exhibition buildings a few moments later. The catalogue contained lists of about eight hundred animals, works of art and industry relating to dogs, and all other appliances required in training and bringing up these faithful and useful animals.

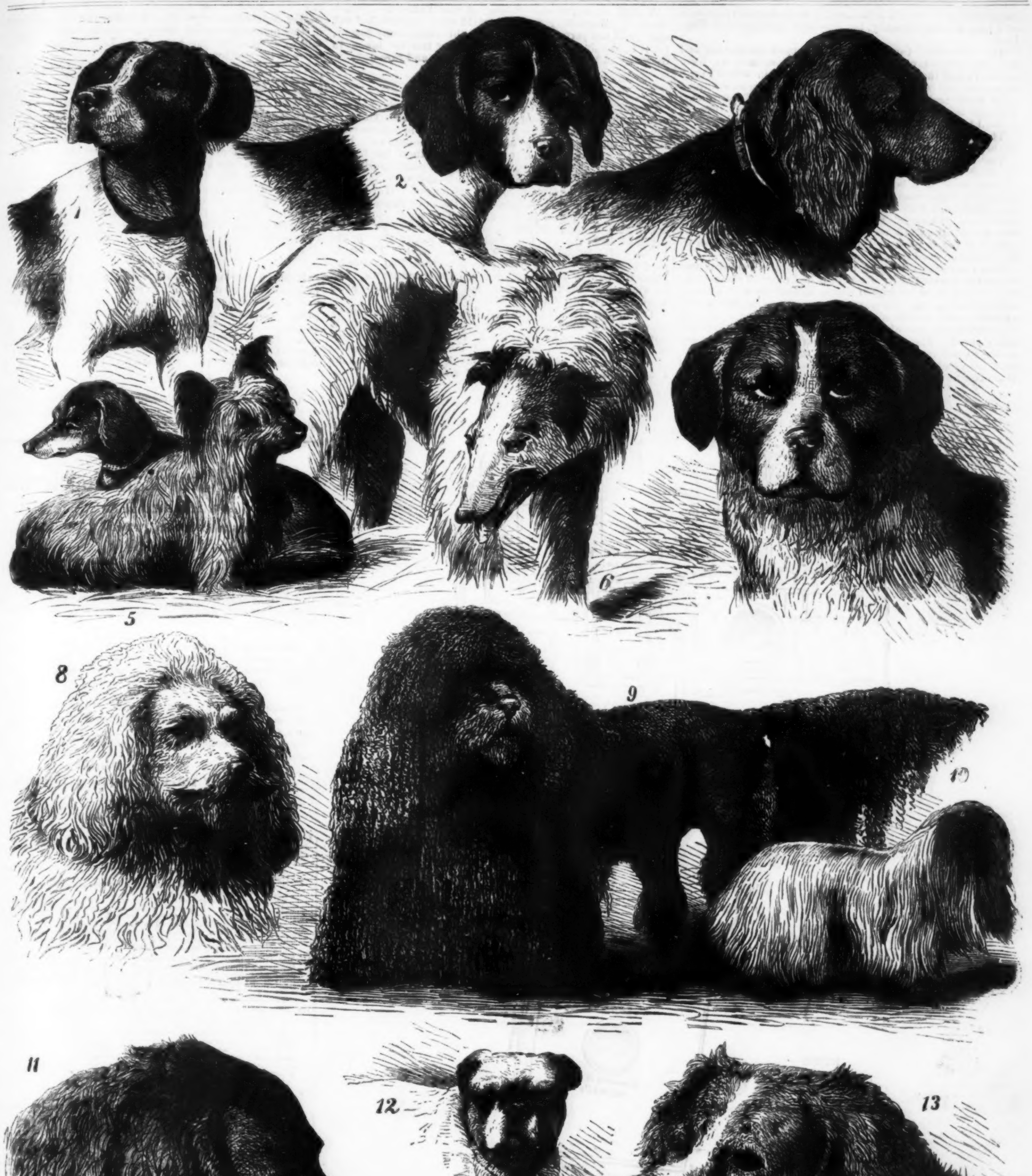
The Exhibition buildings contained a photographic studio, conducted by the well-known photographer Sophus Williams, where exact and true pictures of all the prize dogs were taken, a number of which are shown on the opposite page, taken from the *Leipziger Illustrirte Zeitung*.

Near the entrance to the Exhibition we found a collection of sixty Newfoundland dogs, of which a few were really excellent specimens, whereas others were rather below the normal standing. The same was the case with the collection of Alpine or St. Bernard dogs, which contained about eighty specimens, both long and short haired.

Fig. 11 of our cut represents the beautiful black Newfoundland dog "Moldau," bred in Germany by Mr. Sidney Smith, who also exhibited the uniformly colored, reddish-yellow, long-haired, Alpine dog "Cæsar" (imported from Switzerland). Fig. 7 shows the short-haired white and yellow spotted Alpine dog "Barry."

The German mastiffs were represented by very elegant specimens, Messrs. Messner and Dr. Caster having furnished perfect giants.

But few bulldogs were exhibited, and they mostly all had



THE PRIZE DOGS AT THE INTERNATIONAL BENCH SHOW AT BERLIN.

No. 1. Naso III. (Heavy Pointer). No. 2. Diana (Heavy Pointer). No. 3. Mylord (Long-Haired Pointer). No. 4. Fina (Terrier). No. 5. Skye (Skye Terrier). No. 6. Flock (Persian Greyhound). No. 7. Barry (Short-Haired Alpine Dog). No. 8. Hans (Poodle). No. 9. Nero (Long Curled Poodle). No. 10. Violet (Silk Terrier). No. 11. Moldau (New Foundland). No. 12. Molly (Pug Dog). No. 13. Cæsar (Alpine Dog). No. 14. Blitz (Silk Spitz).

the double nose, which is thought to be a characteristic sign of a pure race in Germany, but has been condemned in England.

The "poodles" formed one of the most interesting and best represented classes of the Exhibition, and we have shown two of the best specimens in our cut, in which Fig. 8 represents the snow-white poodle "Hans," whose unique head dress and whiskers caused considerable merriment; whereas the black, long-curled poodle "Nero" (Fig. 9) seemed to be wandering about under mourning drapery.

The pug dog "Molly" (Fig. 12), and the silk spitz (Fig. 14) are Berlin specialties.

The silk terriers, or Halifax terriers, proved to be one of the most attractive features of the Exhibition. The most of them were of a beautiful silver-gray color, and were exhibited in glass cases, and some of them wore woolen socks to prevent their fine silken hair from becoming entangled in their toes. "Violet" (Fig. 10), the property of Mr. John Hustler, of Bradford, received the first prize, and really deserved it, for it presented a wonderful appearance with its long hairs combed over its face.

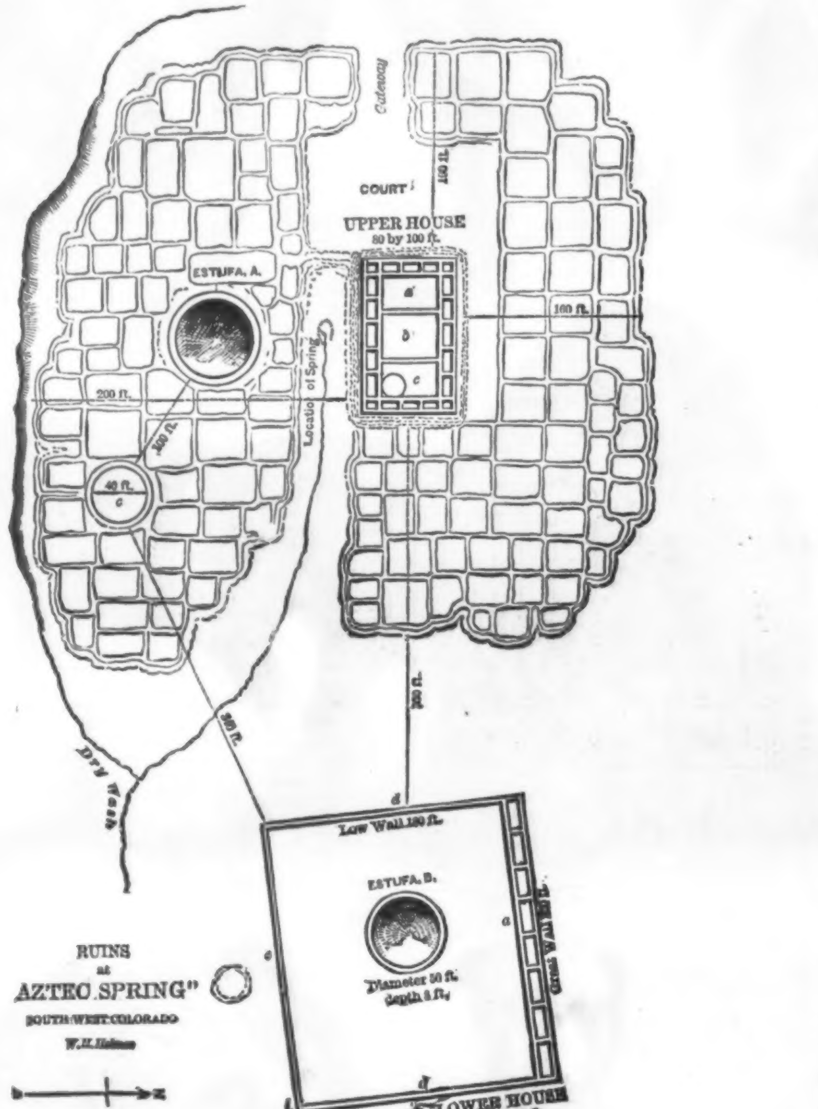
From morning till night the spectators surrounded this animal and stared at it, although it had more of the appearance of a mass of entangled silken threads than of a living animal; but as the price asked for it was 20,000 marks ($5,000), every one desired to see the costly dog. Among the terriers the smooth Manchester terriers were very well represented. The shaggy haired were less in number, but as the Skye-terrier "Skye" (Fig. 5) received the first prize, and his competitors were almost his equals, the quality of this class no doubt stood in a higher rank than its number.

A short time after the closing of this Exhibition, bench shows in Magdeburg and Elberfeld were opened, but our space will not permit us to dwell on this subject any longer, yet it is pleasing to notice the growing interest taken in Germany in breeding and bringing up fine and rare dogs.

AZTEC RUINS, COLORADO.

ONE of the most interesting of the many groups of Aztec ruins scattered throughout Colorado, New Mexico, and Arizona, are those at "Aztec Springs," located in a depression between the Mesa Verde and the Late Mountains. It is said that, until within six or seven years, there has been a living spring at this place, located at the point marked on our illustration, the presence of which undoubtedly determined this as a desirable point for settlement. Hayden, in his report, says that these ruins form the most imposing pile of masonry yet found in Colorado. The whole group covers an area of about 480,000 square feet, and has an average depth of from three to four feet. This would give in the vicinity of 1,500,000 solid feet of stone work. The stone used is chiefly of the fossiliferous limestone that outcrops along the base of the Mesa Verde a mile or more away, and its transportation to this place has doubtless been a great work for a people so totally without facilities.

The upper, probably principal, house is rectangular, measures 80 by 100 feet, and is built with the cardinal points to within 5°. The pile is from 12 to 15 feet in height, and its massiveness suggests an original height at least twice as great. The plan is somewhat difficult to make out on account of the very great quantity of *débris*.



We must give some attention to the class of hunting dogs, which was not represented as well as at the last show at Hanover. German pointers, short haired, were represented by ninety specimens, and about twenty to twenty-five pups—a proof of the great interest taken in breeding this special class of dogs. "Diana" (Fig. 2) received the prize of 900 marks given by the "Hector" Society, upon which the animal was to belong to the Society; but its owner would not even part with his pet for a much greater sum, and, consequently, was compelled to forfeit the first prize. The long-haired German pointers were not well represented. "Mylord" (Fig. 3) carried off the prize in this class.

The English pointers showed an extraordinary elegance of appearance, and the heavy pointer "Naso III." (Fig. 1), who received a first prize, is a fine representative of his class. The English Gordons and Irish setters, as also the land and water spaniels, were all well represented, but it would carry us too far to go into a detailed description of each class and its prize dog. The beautiful Scotch deer-hounds did not receive much attention, but nevertheless each received a prize. Fig. 6 represents Mr. Ripkes' Persian greyhound. The fox dogs (small) and beagles could hardly compete with the dogs of the better English kennels, but, nevertheless, presented a very picturesque and highly interesting appearance. The fox terriers were represented by twenty specimens, and as the female dogs of the class always show a much finer and more elegant development than the males, they carried off the prize, "Fina" (Fig. 4) having received the first.

The walls seem to have been double, with a space of seven feet between. A number of crosswalls at regular intervals indicate that this space has been divided into apartments, as seen in the plan.

The walls are 26 inches thick, and are built of roughly-dressed stones, which were probably laid in mortar, as in other cases.

The inclosed space, which is somewhat depressed, has two lines of *débris*, probably the remains of partition walls, separating it into the three apartments, *a*, *b*, *c*. Inclosing this great house is a net-work of fallen walls, so completely reduced that none of the stones seem to remain in place; and I am at a loss to determine whether they mark the site of a cluster of irregular apartments, having low, loosely-built walls, or whether they are the remains of some imposing adobe structure built after the manner of the ruined pueblos of the Rio Chaco.

Two well-defined circular inclosures, or *estufas*, are situated in the midst of the southern wing of the ruin. The upper one, A, is on the opposite side of the spring from the great house, is 60 feet in diameter, and is surrounded by a low stone wall. West of the house is a small open court, which seems to have had a gateway opening out to the west through the surrounding walls.

The lower house is 200 feet in length by 180 in width, and its walls vary 15° from the cardinal points. The northern wall, *a*, is double, and contains a row of eight apartments about 7 feet in width by 24 in length. The walls of the other sides are low, and seem to have served simply to inclose the great court, near the center of which is a large walled depression (*estufa B*). No other ruins were observed in the neighborhood of these, although small groups are said to exist along the base of the Late Mountains, a few miles to the southwest.

The little squares which surround the more imposing portions of the ruins are probably the remains of less pretentious dwellings. They are not of uniform size; neither are they arranged in regular order. The walls are simply marked by low lines of loose rubble, the quantity of which would indicate nothing but a very low wall, and all of which, as well as the larger structures, when occupied, were covered with some kind of a roof. As they now appear, they are more like a cluster of open pens, such as are used at the present time by the Moqui tribe of Indians for the keeping of sheep and goats. A somewhat singular circumstance may be noticed, in connection with this portion of the ruins, viz: the fact that the number of minor divisions in dwellings upon each side of the open or dividing space is exactly equal in number—70.—*Mining and Scientific Press.*

POWDER IN METAL BOXES.—It appears that gunpowder preserved in contact with certain metals, especially zinc and copper, undergoes a gradual change. Potassium sulphide, sulphate, and carbonate, and ammonium sesquicarbonate are produced along with sulphides and basic salts of the metals derived from the decomposition of the brass of the boxes. The strength of the powder was found considerably reduced.—*E. Pothier.*

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